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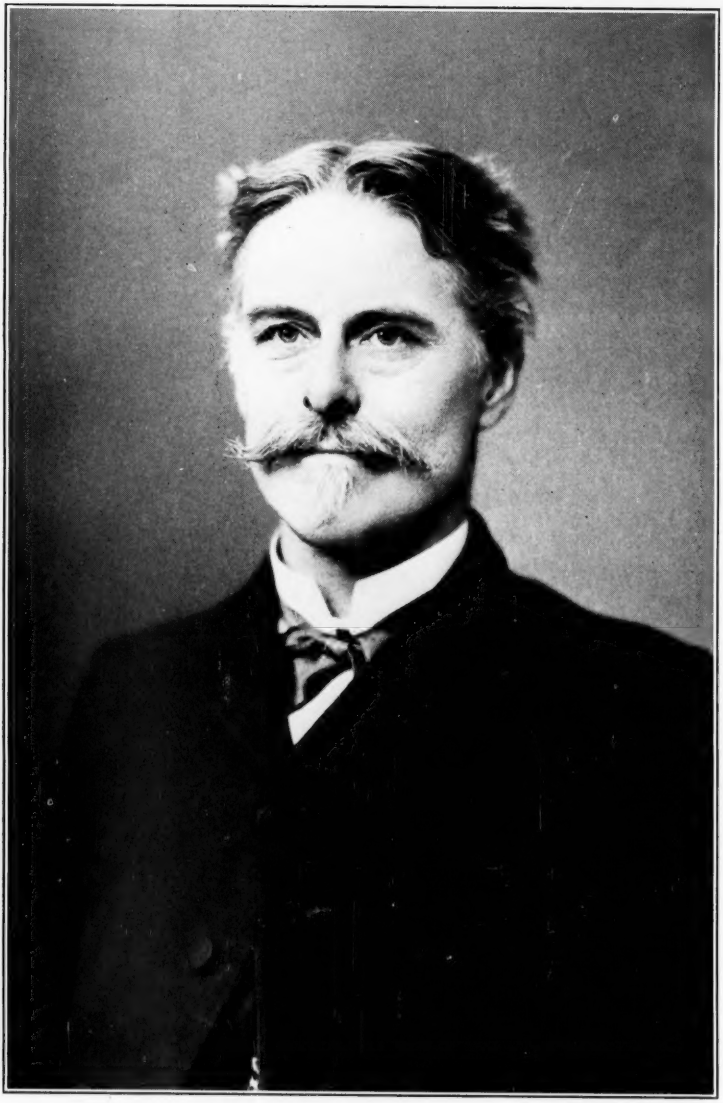


EDWARD DRINKER COPE

1840–1897

UNIV. OF MICH.

Cope—the Man

By E. C. Case

". . . and this I ha' read that another man said . . ."

THERE are men still living who are far better qualified than the writer to tell of the personality of E. D. Cope because they had closer association with him and his time, but the generation is passing. Many who knew Cope have left their impressions recorded in criticism and appreciation. The writer knew Cope slightly, as a younger man knows an older and an honored leader. He knew many of Cope's associates and helpers somewhat intimately and has heard at first hand many relations of the incidents of his career. As time dims recollections and repetition distorts the accounts of various actions it is worthwhile to place in fairly fixed form a picture of the man as he was. This has been done so well and so voluminously in Osborn's *Cope—the Master Naturalist* that the excuse for a further statement is that this is a vignette—perhaps more likely to be read because of its compression.

Osborn, in his characterization of Jos. Leidy (*Impressions of Great Naturalists: 136*), gives us the key to Cope's character and the impulse of his activities. "Your scientific genius may hitch up with a star on the one hand and with an anchor on the other. Whereas Leidy was essentially a man of peace, Cope was what might be called a militant paleontologist. Whereas Leidy's motto was peace at any price, Cope's was war whatever it cost."

In Cope there was a compulsion to activity and to dominance that could not be denied. No man ever lived more completely the unrestful vision of Browning:

> But what if I fail of my purpose here,
> It is but to keep the nerves at strain,
> To dry one's eyes and laugh at a fall,
> And, baffled, get up and begin again,—
> So the chace takes up one's life, that's all.

Cope had a larger degree of success than most men, but also a larger demand; he died broken before his time with many of his plans and hopes unfulfilled.

It is easier to understand Cope's life if one believes that each individual reacts to the influence of his heritage of ancestral traits. Back of the relatively few Quaker progenitors was a long list of men of ambition, of action and of success, which extended from before the Norman conquest up to 1861. With Oliver Cope, the great grandfather, the Quaker influence was introduced.[1]

The blend of Quaker opinion and influence in no wise dulled the vigor of the stock. In grandfather and father it found expression in successful commercial activity. In the son it centered in an acute intellectual curiosity, and a strong will housed in a splendidly efficient brain. Many generations of

1 The history is here obscure. It is certain that after Oliver Cope's removal to America he was a member of the Society of Friends. Perhaps the adoption of the Quaker tenets was earlier.

combative, dominating personalities could not be suppressed by three generations of Quaker repression. The fighting man, denied arms by his father's belief, became a "militant paleontologist" and battled with tongue and pen for his convictions and for what he believed to be his rights.

Unhappily, the battle was not all with other men and with external obstacles. Those who know his life history, know that the struggle with the inhibitions of his upbringing was long and hard, and brought enduring scars. Realization of the verities of biology compelled him to question many things accepted in the impressionable years of his youth. Though he abandoned the faith of his father and withdrew from the Society of Friends, he never lost his conviction that there existed some benevolent external power and never became purely mechanistic in his philosophy. Only those of his time who had a similar training in their youth and later encountered the facts and principles of biological science can realize the confusion which resulted when previously undoubting faith met the challenge of logical reasoning.

The clue to an understanding of Cope's life is the realization that he was essentially a fighting man, expressing his energy in encountering mental, rather than physical difficulties; joining combat armed with the spoken and written word rather than sword and shield, retaining the fighter's joy in strife, and sharing the fighter's relief from excessive toil in social indulgence. The soldier back from the field not uncommonly kicks up his heels.

Cope, the fighter, planned his campaigns, laid up a treasure of ammunition, fought with skill and intense concentration. He hated opponents he could not respect and gave them heavy blows, how and when he could. He met honest opposition with a vigor honoring his foe, but fraternized cordially after the battle.

Like any aggressive leader, driven by the impulse to prevail and oppressed with the many time-demanding duties imposed by his initiative, he was unable to maintain at all times an objective point of view, or to consider his own work, or that of others in a judicial manner. He became in many cases a propagandist, and condemned as propaganda the statements of his adversaries. Dominance in intellectual leadership demands the same aggressive action, defense of positions taken and repulse of attack, as dominance in physical strife. Rapidity of action, abundance of ammunition, marshalling of allies and crushing of an opponent are all essential. Cope, the descendant of fighting forebears, bred true to their blood.

As natural gifts (inheritance) Cope had genius, intuition, an extraordinary memory and a strong will. By accident of fortune he had ample financial resources during a part of his career. By training he was at ease with all people and had the ability to press his points by tongue and pen. He had the virtues and faults of every man of action. Generous and loyal to his helpers and friends, quick to wrath, but just as quick to advise and aid. Capable of intense concentration and persistence in his work and capable of just as unrestrained participation with his companions in the time of relaxation.

He had the faults of every leader, concentration on the furtherance of his own plans and interests, a disinclination to yield to the ideas of others, a thorough belief in the causes he espoused and a not too scrupulous conscience in their defense or in his attack upon opposing views. His enemies were wrong and those who, in his opinion, were wrong were his enemies. The

occasions when differences of opinion were talked over and adjusted were fewer than those in which opposition met with vigorous, sometimes violent rebuttal.

A very old precept of strategy is that the advantage is to the party who arrives at the point of combat first with the most power and equipment. True to this precept Cope was avid in acquiring material and especially so in acquiring the prestige of credit for discovering and reporting new forms of life. In his time the description of a new species was ranked as a major scientific accomplishment and Cope "acquired merit" and stored up ammunition with untiring industry. Osborn lists 1282 genera and species of fossil vertebrates described by Cope; there were many new recent forms. Necessarily there was much of haste and inadequate description. Genera and species were named by telegrams and short notes addressed to colleagues and intended for publication. Names and very abbreviated descriptions were attached, seemingly as afterthoughts, to papers on unrelated subjects.

In all the criticism that has been pronounced upon Cope, one charge is conspicuously missing. He was never accused of appropriating the work of men working under or with him. His work, his errors and his accomplishments were his own.

Cope had many advantages and opportunities. Perhaps the most enjoyed among these was a goodly number of able, vigorous and enterprising adversaries. A well equipped and ardent fighter with no one to attack would be a pathetic figure. Cope was spared such embarrassment. Indeed, if there were symptoms of a devastating calm, he was quite ready to administer a provoking criticism that would restore the preferred state of active controversy.

Leidy he disliked and caviled at because Leidy preferred to state his evidence and let the truth become apparent. A kindly providence supplied a major opponent and a major objective in his campaigns, in Professor O. C. Marsh. The judgment of years inclines to the opinion that Cope was the better naturalist and more gifted scientist of the two, but there is no doubt that Marsh was as good a fighter as Cope and a better strategist. So far as the evidence of professional honors and of emolument goes, Marsh carried the day. Both men contributed largely to the advance of their favorite science, both men spent their considerable fortunes in its service and died relatively poor.

Aside from its picturesque incidents and the unholy joy it gave the onlookers, the whole controversy was useless, undignified and far from bringing credit to either principal. Anger begat malice and malice fathered trickery at times. The incidents of the struggle have been told and retold and have undoubtedly been embroidered to make them more piquant. They will be retold and rewhispered for years to come.

The father of the writer of this sketch was the editor of a scientific journal published in a mid-western state during the years when the Cope-Marsh contention was at its hottest. With many another he tired of its trivialities and disingenuousness and composed and printed a small broadside that he chose not to sign. After all the years between, it may be reprinted, as it expresses the opinion of many a colleague of Cope and Marsh.

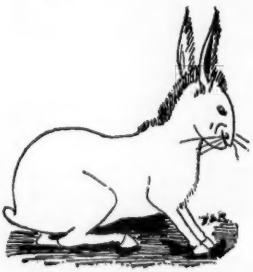
1889

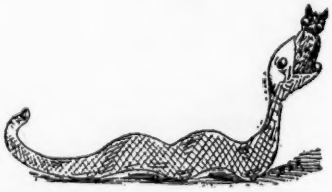
The Scientific Scrap, or the Battle of the Bone Hunters.

[AFTER BRET HARTE.]

1. Unheeding how the Science Club of Stanislaus met with its dreadful fate,
Forgetful of the sandstoned abdomen of Dean and Thompson's caved-in pate,
Our Eastern men of lore have taken up the game, "tho' not the proper plan,"
Of laying for and roasting each the other scientific man.

2. Professor Cope, tho' Quaker bred and slim, seems spoiling for a fight,
And goes for Marsh of Yale in terms and style distinctly impolite;
His mio-plio-oro-hippian record rudely breaks,
His Dinosaurs derides,—Laornian birds he scoffs as quaternary snakes.

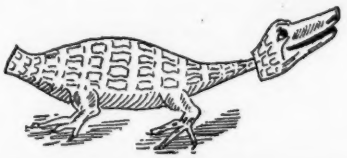




3. He gives it out quite cold that Marsh's "rock sharp" reputation
Is built upon the fossiliferous finds of sundry other men,
And in his genial, gentle way he charges "misappropriation,"
And writes some things quite incompatible with scientific pen.

4. Then Marsh of Yale, with intra-mundane fire, cretaceous fossils hurls
And uncelestial words from palæontologic worlds,
To prove the ways of Cope are dark and all his tricks are vain
And that he knows of fossils little else except to swipe them in.

5. Likewise he hints, in language plain, Cope may know beans, but not much more,
Especially of bones ;—because he fashioned out *Elasmosaur*
From vertebræ transposed from head to tail—a style extremely rare,
And very ill-arranged for "Las," as one could safely swear.



6. Some other members take a hand in this wild scientific mill.
Grim Powell too, gets in his licks with true anthro-pologic skill.
And Silliman and Williston, with Harger and Grinnell,
Stand round the ring and back their men with neoteric yell.

7. Now lest, as on the Stanislaus, the experts all engage
In this discussion "with the remnants of a palæozoic age,"
And the atmosphere grow blue, and the torn up ground be strewn
With hair or wigs of scientific gents, they'd better stick to bones,
And leave Kilrain and Sullivan to swap the prize ring words and tones.

T. S. C.

Cope was born and bred a Quaker, but with a long line of fighting ancestors. His inheritance compelled aggressive action, and methods sometimes hasty and regrettable. Like many leaders he accomplished much that benefited his followers. We can afford to smile at his foibles and palliate his errors. We owe a large mede of gratitude for the good work done and the revelations of so many of Nature's secrets.

MUSEUM OF PALEONTOLOGY, UNIVERSITY OF MICHIGAN, ANN ARBOR, MICHIGAN.

Excerpts, Mainly Herpetological, from the 1858 Notebook of Edward D. Cope

EDITED BY E. R. DUNN

FOREWORD.—Recently a number of Cope documents were given into my care by his daughter, Mrs. William H. Collins. One of these is a notebook, six and a half by eight inches, backed with brown paper and containing 32 pages. On the outside is the name Edward D. Cope. The first page contains the title: "Observationes in plantas atque animalis consuetudinesque, MDCCCLVIII," and beneath this is a six line quotation from Vergil (Buc. Ecl., 7, 45). The second page is blank.

The other pages are filled with observations, beginning on Jan. 1, and ending on July 16, 1858. There are more observations on botany than on any other subject. There is a good deal of ornithology, and a little mammalogy and entomology. Herpetology is less extensive than ornithology, but it is the only field in which Cope gives evidence of intention to publish.

The extracts to follow include all references to herpetology. I have omitted or abbreviated some rather long descriptions, and summarized his list of his collection. My notes are in square brackets. Four new generic and four new specific names are proposed in this MS of which only one specific name was published. I have not written them out in full.

From internal and external evidence it is possible to localize these observations somewhat. On March 30 he notes a new species of *Rana*, which he later states came from Fairfield, the Cope estate on the York Road just outside of Philadelphia. A letter to his father indicates that he went to Jennersville, Chester Co., Pa., to work on a farm, in May, and except for occasional weekend visits home remained there until fall, although he visited Londongrove, some six miles east of Jennersville, on June 22, and possibly also on June 29 when he notes *Ambystoma conspersum*. Elk Creek, mentioned for June 25, is west of Jennersville.

Mentioned in the list of his collection are: Byberry, in the extreme north of Philadelphia County; Marple, in Delaware County, north of Media, where he worked on a farm in the summers of 1856 and 1857; and Silver Lake, which I have been unable to locate.

E. R. DUNN

2 [nd. Month] 24 [th.] Hylodes (D.....) Pickeringii [a new subgeneric name is here proposed]—duorum quorumque mensurae. [measurements omitted].

3 6 Tropidonotus sipedon dua personae. [description and scale counts omitted].

3 14 Lophophanes bicolor. Evoe! Ver advenit.

3 20 Symplocarpus foetidus herbescens. Emys (Nanemys Ag.) var. Beta: Ranae primae vocantes. "Herp. vern"; et ego reperiit, nempe: Hylodes (C.....? [new generic name] Cope p——— [new specific name] (Cope). Sed D..... preoccupatum est, atque C..... non propria, igitur H..... propono. Gen. H..... (Cope) [new

generic name, description omitted] H. Pickeringii typicus; H. ocularis; et H. p..... nempe [a long description omitted] in palude inventus prope Philadelphia. [It seems to have been *Hyla crucifer*].

3 21 Rana palustris saliens.

3 27 Malacoclemmydem palustrem emi [three drawings of "head and hind foot of *Malacoclemmys* showing generic characters," three similar figures for *Nanemys*—see accompanying figure].

Head and hind foot of
Malaeoclemmys;
showing generic characters &
Heads hind foot of Nanemys showing the generic characters. Os maximae lagenae six quattuor et hemiuncia.

Fig. 1. Specimen page from Cope's 1858 Notebook.

3 29 Accepi serpentem unam, ranam unam, salamandres quinque, etc.

3 30 Rana fontinalis, et Rana halecina et R. palustris magnis vocibus clamantes, visi. Rana m..... [new specific name] (Cope) pro tem. Differt ab Ranam fontinalem [a description of what would seem to have been a young *catesbeiana* follows] Fam Salamandridae, SubF. Ensatininae, Gen S——— (Cope) (anglice) Tongue pedicellate [etc.]. A genus nearly allied to Heredia (Girard) of the Pacific slope, and representing it in the Miss. valley. Species S——— g——— (Cope). Form slender [etc. the description is of *Hemidactylium scutatum*] Habitat, near Chicago, Ill. J. Cassin.

3 31 Speciorum in collectione mea, enumeratio et descriptio. [He had a diamond-back terrapin and a spotted turtle; a skin of a milk snake from Byberry, two ringnecked snakes, a *Storeria dekayi* from Chicago, two *Natrix sipedon*, two *Heterodon;* a *Holbrookia* from Texas and a *Phrynosoma douglassii* from California; toads from Marple and Fairfield, peeper, his "new" *Hyla*, two woodfrogs from Marple, green frogs from Marple and Fairfield, "new" *Rana* from

Fairfield; newt from Silver Lake, two newts from Chicago, 6 red-backed salamanders from Marple and the "new" *Hemidactylium* from Chicago].

4 3 Alteram Hyla p——— cepi!, acto clamantis. H——— cum Hyla congenerica est.

4 5 Ptychemydem rugosum emi.

4 10 Magnam multitudem Ranae halecinae visi atque immensis vocibus audivi. Rana palustris. Acris crepitans (Baird), personas quatuor cepi. Plethodon erythronotus. Hyla (new species).

4 17 Tropidonotus sirtalis. Coryphodon constrictor magnus, celer, persecutus sum! Hyla Pickeringii. Acris crepitans. Rana halecina et fontinalis. Rana sylvatica, pulcherrima, rubinea. Nanemys guttatus. Helocoetes feriarum Baird! Mirabile dictu! sed his descriptione Bairdii differt. Dentium palatinorum fasciculinarium interiorum posteriores aliquando sunt. Femur seu tibia multo minor quam corporis longitudinis dimidium est.

4 19 Hyla versicolor vocans.

4 24 Pseudotriton ruber! Oculi chrysei, macula nigra medii utriusque, cauda tertium partem ab basi cylindrica, compressa ultra, paecipuo ad finem; dorso multis magnis abnormis maculis fusco-nigris, subter pallida rubra.

4 30 Plethodon (Desmognathus) nigrum in lue atque aqua (non est Plethodon?)

5 1 Hyla Pickeringii, Ranae sylvatica et pipiens. Cistudo virginea. Tropidonotus? Salamandrem quem putavi Plethodontem, non est. Vide! B——— (Cope). [The description indicates *Desmognathus*. He had three, one with and two without vomerine teeth]. Genus abnormis, inter Tritoninae atque Spelerpinae (Dact. 4–5).

5 7 Antrostomus vociferus! rarissima avis!

5 8 Salamandrem quem Plethodon nigrum puto, cepi. Tropidonotus ordinatus, ferox.

5 20 Tropidonotus sipedon. Chrysemys picta.

5 23 Ozotheca odorata.

5 24 Hyla Pickeringii, paulo vocant. Hyla versicolor! clare clamitans—personas quatuor cepi!

5 28 Vespertiliones nondum videri!

6 4 Ablabes punctatus pers. duae. Carphophis amoena! Spelerpes bilineatus!

6 5 B———quadrimaculata [the *Desmognathus* of 5 1].

6 6 Ablabes triangulum! (v. eximius). Coronella getula! ab H. V. capta.

6 7 Tropidonotus leberis! in aqua natans, sipedonis more.

6 10 Tropidonotus sipedon. Pseudotriton ruber.

6 21 Calemys Muhlenbergii. Chelydra serpentina. Antrostomus vociferus triste clamitans, apud aqua.

6 22 Londongrove.

6 25 (25th on Elk). Spelerpes bilineata. Ozotheca odorata. Cistudo natans.

6 29 *Ambystoma conspersum!!* In lue sicca, ubi lacus calcareus fuerat, in sylva. Aquam odit; pedibus recte ambulat; oculi aterrima.
7 2 Pseudotriton ruber.
7 6 Ablabes triangulum eximius juvenis. Tropidonotus ordinatus.
7 16 Finis!!!!!

Generic Names Proposed in Herpetology by E. D. Cope[1]

By E. R. Dunn and M. T. Dunn

SOME years ago, in order to facilitate our own work on Central America, and in order the better to answer numerous inquiries regarding Cope types supposed to be in the collection of the Philadelphia Academy, we prepared a list of the nine hundred and odd species of living amphibians and reptiles described by Cope, and hope eventually to publish this list together with the present location and condition of the types. We thus became fairly conversant with Cope's herpetological work, as far as it pertained to new species, and having ourselves felt the need for an accurate list of Cope's genera of these groups we have prepared the following for the Cope anniversary number of the journal named in his honor.

We have used Osborn's bibliography (1930, Biographical Mem. Nat. Acad. Sci., 13: 172–317) with much profit. It has a few omissions, at least one erroneous inclusion, and a few erroneous datings, but these do not seriously detract from its usefulness. We have checked the names with those in the following lists:

A–L. Neave, 1939, Nomenclator Zoologicus, Vol. 1–2.

M–Tret. Schulze, Kukenthal, and Heider, 1931–1938, Nomenclator animalium generum et subgenerum.

Trid.–end of alphabet. Scudder, 1882, Nomenclator Zoologicus; the Index Zoologicus, 1880–1900; and Zoological Record, 1902.

Cope published many new generic names, or emendations of older ones, without any indication that they were new. Some of his new generic names were published in such unlikely places as indices. We feel no real confidence that we have found them all, but a comparison with the A–L volumes of Neave (1939) shows that we have 19 generic names not in Neave, and 26 not correctly cited by that work.

Cope cited himself as author of a number of generic names which he was not the first to propose. The author most concerned is Fitzinger, many of whose genera were proposed with type but without diagnosis. The rules in force during most of Cope's working period held such genera invalid, and Cope, who provided the first diagnosis for a number of such names, regarded himself as the legitimate author. Boulenger, and a number of others, regarded these genera as Cope's. The present rules do not require diagnosis of genera; they do require type designation, and under these rules such genera as Fitzinger's are valid. This list of Cope genera does not include any such names.

1 Contributions from the Biology Department of Haverford College No. 53.

Some generic names by other authors (principally Hallowell and Dugés) appeared first in papers either edited or written by Cope and have been attributed to Cope by other authors, although Cope never claimed them as his. This list does not include such names.

Cope produced two absolute *nomina nuda,* which we list. One of these names is in teiid lizards; the other in colubrid snakes. The latter was later validated by him.

Present rules state that a generic name without a designated type is invalid. Twenty-nine of Cope's generic names are in this category. We list all of these. For twelve genera of scincid lizards, and for two genera of teiid lizards there is given a diagnosis but no idea of the content, and for one genus in each family we have been unable to find any species that fits the generic diagnosis. These fourteen genera have never been used by other herpetologists and we do nothing to validate them.

For one colubrid snake genus Cope specifies a section of an older genus. A subsequent type designation has been made, which we cite.

For one salamander name, four frog names, three lizard names, and six snake names there is no designated type, but there is a list of included species. For some of these we have noticed previous type designations, which we cite: for the rest we have designated types.

Cope proposed new names in the form of altered spellings for twelve frog genera, four lizard genera, and twenty-six snake genera. Some of these are doubtless unintentional typographical errors, but we have tried to list all letter combinations used by Cope for the first time as generic names. We have considered it beyond our province to determine the type species of these genera.

For one salamander genus, three frog genera, one lizard genus, and eleven snake genera Cope mentioned more than one included species but designated a type. Seven of his salamander genera, twenty-nine of his frog genera, his four turtle and two crocodilian genera, twenty-eight of his lizard genera, and sixty-five of his snake genera (i.e., well over half of his genera) were proposed as monotypic.

We have not considered it our province to correct Cope's citations of species used as types or included in his new genera, but have put them down as he cited them.

We have used the abbreviation PANSP for Proceedings of the Academy of Natural Sciences in Philadelphia, JANSP for the Journal of the same Academy, PAPS and TAPS for the Proceedings and Transactions of the American Philosophical Society. The Proceedings of the Academy of Natural Sciences of Philadelphia for any given year were often partly published in the following year, and the same is true for the Proceedings of the United States National Museum. The volume number of both these journals is always cited; the year is cited in parentheses only if it does not agree with the date of actual publication.

We list here 223 generic names; 9 proposed for salamanders, 47 for frogs, 4 for turtles, 2 for crocodilians, 51 for lizards, and 110 for snakes. Nearly half of these were proposed in the sixties, the years of Cope's greatest herpetological activity. One salamander name was published in 1859; six lizard

and four snake names were published posthumously in 1900. Cope's activity in the four intervening decades is here tabulated.

	Genera Described			
	sixties	seventies	eighties	nineties
Salamanders	5	—	2	1
Frogs	31	9	6	1
Turtles	2	—	—	2
Crocodilians	2	—	—	—
Lizards	17	6	4	18
Snakes	47	12	22	26
	104	27	34	48

Two of Cope's generic names in lizards are preoccupied and have not had substitute names proposed for them. The first, *Liurus*, has not appeared in any list of generic names, and the publication is not listed in Osborn's bibliography. We propose ***Aliurus*** as a substitute name. The second, *Monophorus*, proposed for a genus of scincid lizards with no included species mentioned, has appeared in lists of generic names and in the Zoological Record, but has never been used in herpetology. We do not propose to do anything about this name as we think it should be considered invalid.

CAUDATA

Camarataxis 1859. PANSP, 11: 122. Monotype *Ambystoma maculatum* Hallowell.
Chondrotus 1887. Amer. Nat., 21: 88. Designated type *Amblystoma tenebrosum* Baird and Girard.
Gyrinophilus 1869. PANSP, 21: 108. Monotype *Salamandra porphyritica* Green.
Haptoglossa 1893. PAPS, 31: 334. Monotype *H. pressicauda* Cope, *l. c.*
Linguaelapsus 1887. Amer. Nat., 21: 87. Included species: *Amblystoma annulatum* Cope, *Amblystoma cingulatum* Cope. We designate *annulatum* as type.
Manculus 1869. PANSP, 21: 101. Monotype *Salamandra quadridigitata* Holbrook.
Neurergus 1862. PANSP, 14: 343. Monotype *N. crocatus* Cope, *l. c.*
Stereochilus 1869. PANSP, 21: 100. Monotype *Pseudotriton marginatus* Hallowell.
Thorius 1869. Amer. Nat., 3: 222. Monotype *T. pennatribus* [typ. error for *pennatulus*] Cope, *l. c.*

SALIENTIA

Adenomus 1861. PANSP, 12 (1860): 371. Monotype *A. badioflavus* Cope, *l. c.*
Agalychnis 1864. PANSP, 16: 181. Designated type *Hyla callidryas* Cope.
Amolops 1865. Nat. Hist. Rev., 5: 117. Monotype *Polypedates afghanus* Günther.
Borborocaetes 1866. JANSP, (2) 6: 90. Pro *Borborocoetes* Bell, 1843, not *Borborocoetes* Shoenherr, 1842 (Coleop.).
Bubonias 1874. PANSP, 26: 124. Monotype *B. plicifrons* Cope, *l.c.*
Cinclidium 1867. JANSP, (2) 6: 200. Monotype *C. granulatum* Cope, *l. c.*; not *Cinclidium* Blyth, 1842 (Aves).
Cincloscopus 1870. PAPS, 11: 554. Pro *Cinclidium* Cope.
Colostethus 1866. PANSP, 18: 130. Monotype *Phyllobates latinasus* Cope.
Cophaeus 1889. Bull. U. S. Nat. Mus., 34: 312. Pro *Telmatobius* Boulenger, not Wiegmann.
Cranophryne 1889. Bull. U. S. Nat. Mus., 34: 260. Pro *Cranopsis* Cope.
Cranopsis 1875. JANSP (2) 8: 96. Monotype *C. fastidiosus* Cope, *l. c.*; not *Cranopsis* Adams, 1869 (Moll.)
Craugastor 1862. PANSP, 14: 153. Included species *Hylodes fitzingerii* Schmidt, *Hylodes hallowellii* Cope. We designate *fitzingerii* as type.
Crepidius 1875. JANSP, (2) 8: 97. Monotype *C. epioticus* Cope, *l. c.*: 98. Not *Crepidius* Condaze, 1859 (Coleop.).
Crepidophryne 1889. Bull. U. S. Nat. Mus., 34: 260. Pro *Crepidius* Cope.
Crumenifera 1862. PANSP, 14: 343. Monotype *C. pusilla* Cope, *l. c.*
Didocus 1866. JANSP, (2) 6: 81. Monotype *Rana calcarata* Michahelles.
Enhydrobius 1866. JANSP, (2) 6: 90. Pro *Enydrobius* Wagler.
Epedaphus 1885. PAPS, 22: 383. Monotype *Hyla gratiosa* LeConte.

Epidalea 1864. PANSP, 16: 181. Monotype *Bufo calamita* Laurenti.
Epirhexis 1866. JANSP, (2) 6: 96. Monotype *Batrachyla longipes* Baird.
Eusophis 1870. PAPS, 11: 168. Pro *Eupsophus* Fitzinger, 1843? *Cystignathus nebulatus* Girard is the only species named.
Eusophus 1865. Nat. Hist. Rev., 5: 113. Pro *Eupsophus* Fitzinger? *Cystignathus nodosus* Duméril and Bibron is the only species mentioned.
Grypiscus 1867. JANSP, (2) 6: 205. Monotype *G. umbrinus* Cope, *l. c.*
Hypodictyon 1885. PAPS, 22: 383. Designated type *Phyllobates ridens* Cope.
Incilius 1863. PANSP, 15: 50. Included species [of *Bufo*]: *lentiginosus, cognatus, nebulifer, veraguensis, woodhousei, americanus, coniferus, dialophus.* Kellogg, 1932, Bull. U. S. Nat. Mus., 160: 29, designated *coniferus* Cope as type.
Levirana 1894. PANSP, 46: 197. Monotype *L. vibicaria* Cope, *l. c.*
Lysapsus 1862. PANSP, 14: 155. Monotype *L. limellum* Cope, *l. c.*
Lysapus 1866. JANSP, (2) 6: 89. Pro *Lysapsus* Cope.
Lysopsus 1866. JANSP, (2) 6: 91. Pro *Lysapsus* Cope.
Lystris 1869. PANSP, 20 (1868): 312. Included species *Lystris brachyops* Cope, *l. c., Eupemphix fuscomaculatus* Steindachner. We designate *brachyops* as type.
Malachylodes 1879. PAPS, 18: 264. Monotype *M. guttilatus* Cope, *l. c.*
Mitrolysis 1889. Bull. U. S. Nat. Mus., 34: 312. Monotype *Chiroleptis alboguttatus* Günther.
Nectes 1865. Nat. Hist. Rev., 5: 103. Pro *Pseudobufo* Tschudi.
Ollotis 1875. JANSP, (2) 8: 98. Monotype *O. coerulescens* Cope, *l. c.*
Otaspis 1869. PANSP, 20 (1868): 312. Monotype *Peltaphryne empusa* Cope.
Pharyngodon 1865. PANSP, 17: 193. Monotype *P. petasatus* Cope, *l. c.*, not *Pharyngodon* Diesing 1861 (Helminth), cf. *Triprion* Cope.
Pithecopus 1866. JANSP, (2) 6: 86. Monotype *Phyllomedusa azureus* Cope.
Prostherapis 1868. PANSP, 20: 137. Monotype *P. inguinalis* Cope, *l. c.*
Scytopis 1862. PANSP, 14: 354. Monotype *S. hebes* Cope, *l. c.*
Smilisca 1865. PANSP, 17: 194. Monotype *S. daulinia* [error for *baudinii* Duméril and Bibron].
Spea 1866. JANSP, (2) 6: 81. Monotype *Scaphiopus bombifrons* Cope.
Staurois 1865. Nat. Hist. Rev., 5: 117. Included species: *Ixalus natator* Günther, *Ixalus guttatus* Günther, *Hyperolius plicatus* Günther. We designate *natator* as type.
Stereocyclops 1870. PAPS, 11: 165. Monotype *S. incrassatus* Cope, *l. c.*
Syrrhophus 1878. Amer. Nat., 12: 253. Monotype *S. marnockii* Cope, *l. c.*
Thoropa 1865. Nat. Hist. Rev., 5: 110. Monotype *Cystignathus misiessii* Bibron.
Triprion 1866. PANSP. 18: 127. Pro *Pharyngodon* Cope.
Trypheropsis 1868. PANSP, 20: 117. Designated type *Ranula chrysoprasina* Cope.
Zachaenus 1866. JANSP, (2) 6: 94. Monotype *Cystignathus parvulus* Girard.

Testudinata

Claudius 1865. PANSP, 17: 187. Monotype *C. angustatus* Cope, *l. c.*
Heptathrya 1860. PANSP, 11 (1859): 294. Monotype *Cryptopus aubryi* Duméril.
Pariemys 1895. Amer. Nat., 29: 757. Monotype *Terrapene baurii* Taylor.
Toxaspis 1895. Amer. Nat., 29: 757. Monotype *Terrapene major.*

Crocodilia

Osteolaemus 1861. PANSP, 12 (1860): 549. Monotype *O. tetraspis* Cope, *l. c.*
Perosuchus 1869. PANSP, 20 (1868): 203. Monotype *P. fuscus* Cope, *l. c.*

Sauria

Amoebopsis 1895. Amer. Nat., 29: 758. Monotype *Xantusia gilbertii* Van Denburgh.
Anelytropsis 1885. PAPS, 22: 380. Monotype *A. papillosus* Cope, *l. c.*
Anisoclonium 1900. Report of U. S. Nat. Mus., 1898: 561. A teiid with no included species.
Aporarchus 1885. PAPS, 22: 187. Monotype *A. prunicolor* Cope, *l. c.*
Aristelliger 1862. PANSP, 13 (1861): 496. Included species *Hemidactylus praesignis* Hallowell, *A. lar* Cope. We designate *lar* as type.
Boaclonium 1900. Report U. S. Nat. Mus., 1898: 562. *Nomen nudum* for a teiid.
Cachryx 1866. PANSP, 18: 124. Monotype *C. defensor* Cope, *l. c.*

Caetia 1892. Journ. Morph., 7: 224. Pro *Caitia* Gray, 1838.
Chalcidolepis 1875. JANSP, (2) 8: 116. Monotype *C. metallicus* Cope, *l. c.*
Coccoessus 1862. PANSP, 14: 178. Monotype *Anolis (Coccoessus) pentaprion* Cope, *l. c.*
Coetia 1900. Report U. S. Nat. Mus., 1898: 615. Pro *Caitia* Gray, 1838.
Dicloniscus 1892. Journ. Morph., 7: 235. A scincid with no included species.
Dicloniseus 1900. Report U. S. Nat. Mus., 1898: 621. Pro *Dicloniscus* Cope, 1892.
Dimeropus 1892. Journ. Morph., 7: 234. A scincid with no included species.
Diphalus 1861. PANSP, 13: 75. Monotype *D. fenestratus* Cope, *t. c.*: 76.
Epaphelus 1875. JANSP, (2) 8: 115. Monotype *E. sumichrastii* Cope, *l. c.*
Euchirotes 1894. Amer. Nat., 28: 436. Monotype *E. biporus* Cope, *l. c.*
Furcillus 1892. Journ. Morph., 7: 234. A scincid with no included species.
Haploscincus 1892. Journ. Morph., 7: 234. A scincid with no included species.
Heteroclonium 1896. PANSP, 48: 466. Monotype *H. bicolor* Cope, *l. c.*
Holcosus 1862. PANSP 14: 60. Included species *Ameiva septemlineata* Duméril, *Ameiva sexscutata* Günther. We designate *septemlineata* as type.
Lepidothyris 1892. Journ. Morph., 7: 233. A scincid with no included species.
Liurus 1862. In Slack, Handbook Mus. Acad. Nat. Sci. Philadelphia: 32. Monotype *Hemidactylus ornatus* Hallowell, not *Liurus* Ehrenberg, 1828 (Arach.).
Loxopholis 1869. PANSP, 20 (1868): 305. Monotype *L. rugiceps* Cope, *l. c.*
Lysoptychus 1889. Proc. U. S. Nat. Mus., 11: 397. Monotype *L. lateralis* Cope, *l. c.*
Mancus 1862. PANSP, 14: 339. Monotype *M. macrolepis* Cope, *l. c.*
Mesaspis 1877. PAPS, 17: 96. Included species: *moreletii* Bocourt, *fulvus* Bocourt. We designate *moreletii* as type.
Mesomycterus 1892. Journ. Morph., 7: 236. A scincid with no included species.
Mionyx 1885. PAPS, 23: 96. Monotype *M. parietalis* Cope, *l. c.*
Monophorus 1892. Journ. Morph., 7: 233. A scincid with no included species. Not *Monophorus* Deshayes, 1877 (Moll.).
Monophyaspis 1892. Journ. Morph., 7: 233. A scincid with no included species.
Ollachirus 1892. Journ. Morph., 7: 234. A scincid with no included species.
Oncopus 1892. Journ. Morph., 7: 234. A scincid with no included species.
Ophiognomon 1868. PANSP, 20: 100. Monotype *O. trisanale* Cope, *l. c.*
Panaspis 1869. PANSP, 20 (1868): 317. Monotype *P. aeneus* Cope, *l. c.*
Panolopus 1862. PANSP, 13 (1861): 494. Monotype *P. costatus* Cope, *l. c.*
Paraloma 1862. PANSP, 14: 181. Monotype *Dracontura bivittata* Hallowell.
Pletholax 1864. PANSP, 16: 229. Monotype *Pygopus gracilis* Schlegel.
Podoclonium 1892. Journ. Morph., 7: 235. A scincid with no included species.
Propus 1874. PANSP, 26: 70. Monotype *P. vermiformis* Cope, *l. c.*
Rhineüra 1861. PANSP, 13: 75. Monotype *Lepidosternon floridanum* Baird.
Scartiscus 1862. PANSP, 14: 182. Monotype *S. caducus* Cope, *l. c.*
Scytomycterus 1875. JANSP, (2) 8: 165. Monotype *S. laevis* Cope, *l. c.*
Sesquipes 1900. Report U. S. Nat. Mus., 1898: 561. A teiid with no included species.
Siderolamprus 1861. PANSP, 12 (1860): 368. Monotype *S. enneagrammus* Cope, *l. c.*
Tejaporus 1900. Report U. S. Nat. Mus., 1898: 560. Pro *Tiaporus* Cope, 1894.
Tiaporus 1894. PAPS, 30: 132. Monotype *T. fuliginosus* Cope, *l. c.*
Tretioscincus 1862. PANSP, 14: 184. Monotype *T. castanicterus* Cope, *l. c.*
Tridentulus 1892. Journ. Morph., 7: 234. A scincid with no included species.
Verticaria 1870. PAPS, 11: 158. Designated type *Cnemidophorus hyperythrus* Cope.
Zablepsis 1895. Amer. Nat., 29: 758. Monotype *Xantusia henshavii* Stejneger.

SERPENTES

Acanthocalyx 1895. TAPS, 18: 204. Monotype *Zamenis ventrimaculatus* Gray.
Acanthophallus 1893. Amer. Nat., 27: 481. Designated type *Xenodon colubrinus* Günther.
Adromicus 1900. Report U. S. Nat. Mus., 1898: 734. Pro *Dromicus* Bibron.
Agratomus 1887. Bull. U. S. Nat. Mus., 32: 93. Monotype *Philodryas trilineatus* Burmeister.
Amastridium 1861. PANSP, 12 (1860): 370. Monotype *A. veliferum* Cope, *l. c.*
Amphiardis 1888. Proc. U. S. Nat. Mus., 11: 391. Monotype *Virginia inornata* Garman.
Anoplophallus 1893. Amer. Nat., 27: 480. Pro *Megalops* Hallowell.
Aploaspis 1867. PANSP, 18 (1866): 310. Monotype *Caudisona lepida* Kennicott.

Aporophis 1877. PAPS, 17: 34. Designated type *Lygophis lineatus*.
Apostolepis 1862. PANSP, 13 (1861): 524. Included species: *lepida* Reinhardt, *flavotorquata, orbignyi*. Amaral, 1929, Mem. Inst. Butantan, 4: 109, designated *flavotorquata* as type.
Atheris 1862. PANSP, 14: 337. Monotype *Echis squamatus* Hallowell.
Atomarchus 1883. Amer. Nat., 17: 1300. Monotype *A. multimaculatus* Cope, *l. c.*
Atomophis 1887. PAPS, 24: 58. Monotype *Philodryas trilineatus* Burmeister.
Atretium 1861. PANSP, 13: 299. Pro *"Tropidophis* Gray, 1849, not Bibron, 1843."
Bascanium 1862. PANSP, 14: 338. Pro *Bascanion* Baird and Girard, 1853.
Bothrodytes 1886. PAPS, 23: 495. Designated type *Amphiesma subminiatum* Reinwt.
Cacocalyx 1895. PANSP, 46 (1894): 427. Monotype *Drymobius percarinatus* Cope.
Calloselasma 1860. PANSP, 11 (1859): 336. Pro *Leiolepis* Duméril and Bibron, 1854, not Cuvier, 1829.
Carphoptis 1862. PANSP, 14: 249. Error for *Carphophis* Gervais.
Cemophora 1860. PANSP, 12: 241. Monotype *Coluber coccineus* Blumenbach.
Ceratophallus 1893. Amer. Nat., 27: 483. Monotype *Coluber vittatus* Linnaeus.
Chilomeniscus 1860. PANSP, 12: 339. Monotype *C. stramineus* Cope, *l. c.*
Chilopoma 1875. In Yarrow, Report Expl. Surv. west of 100th Meridian (Wheeler Survey), 5: 543. Monotype *C. rufipunctatum* Cope, *l. c.* Not *Cheilopoma* Murray, 1867 (Coleop.), cf. *Stypocemus* Cope.
Chionactis 1860. PANSP, 12: 241. Pro *Lamprosoma* Hallowell not Kirby.
Clonophis 1889. Proc. U. S. Nat. Mus., 11: 391. Monotype *Regina kirtlandii* Kennicott.
Clothelaps 1895. TAPS, 18: 211. Designated type *Atractaspis hildebrandtii* Peters.
Colophrys 1868. PANSP, 20: 130. Monotype *C. rhodogaster* Cope, *l. c.*
Colorhogia 1862. PANSP, 14: 81. Monotype *C. redimita* Cope, *l. c.*
Crossanthera 1893. Amer. Nat., 27: 481. Monotype *Dendrophidium melanotropis* Cope.
Cryptelytrops 1860. PANSP, 11: (1859) 340. Monotype *Trimeresurus carinatus* Gray.
Cyclagras 1885. PAPS, 22: 185. Pro *Lejosophis* Jan, 1862.
Dianodon 1893. Amer. Nat., 27: 481. Pro *Dinodon* Duméril and Bibron.
Dicraulax 1893. Amer. Nat., 27: 480. Monotype *Holarchus trinotatus*.
Dipeltophis 1887. Bull. U. S. Nat. Mus., 32: 58. Monotype *Leptognathus albocinctus* Fischer.
Diplophallus 1893. Amer. Nat., 27: 483. Monotype *Tropidonotus piscator* Schneider.
Diplophatulus 1900. Report U. S. Nat. Mus., 1898: 956. Error for *Diplophallus* Cope, 1893.
Dirrhox 1887. Bull. U. S. Nat. Mus., 32: 57. Pro *Callirhinus* Girard, nec Cuvier.
Echinanthera 1894. Amer. Nat., 28: 841. Monotype *Aporophis cyanopleurus* Cope.
Entacanthus 1900. Report U. S. Nat. Mus., 1898: 780. Pro *Entechinus* Cope, 1895.
Entechinus 1895. PANSP, 46 (1894): 429. Monotype *Cyclophis major* Günther.
Enulius 1871. PAPS, 11: 558 (Feb. 17); Third Report Peabody Inst., 1870: 80. Monotype *E. murinus* Cope, *l. c.*
Epiglottophis 1891. Amer. Nat., 25: 157. Designated type *Spilotes deppei* Duméril and Bibron.
Eumesodon 1860. PANSP, 12: 262. Designated type *E. semicarinatus* Cope, *t. c.*: 263.
Euprotodon 1860. PANSP, 12: 262. Designated type *Coluber aulicus* Linnaeus.
Eurystephus 1862. PANSP, 14: 337. Monotype *Elaps irregularis* Reinhardt.
Gastropyxis 1861. PANSP, 12 (1860): 558. Monotype *Dendrophis smaragdinus* Boie.
Geagras 1875. JANSP, (2) 8: 141. Monotype *G. redimitus* Cope, *l. c.*
Genhosteus 1874. Amer. Nat., 8: 432 (July). Error for *Gerrhosteus* Cope, 1874.
Gephyrinus 1886. PAPS, 23: 492. Monotype *Dryophis fronticinctus* Günther.
Gerrhosteus 1874. PANSP, 26: 71 (May). Monotype *G. prosopis* Cope, *l. c.*
Glaniolestes 1862. In Slack, Handbook Mus. Acad. Nat. Sci. Philadelphia: 41. Pro *Heteronotus* Hallowell and *Graya* Günther.
Gyalopion 1860. PANSP, 12: 241. Monotype *G. canum* Cope, *t. c.*: 243.
Gyalopium 1863. Silliman's Journ., (2) 35: 456. Pro *Gyalopion* Cope.
Haliophis 1862. PANSP, 14: 77. Error for *Alsophis* Fitzinger, 1843, not *Haliophis* Rueppell, 1829 (Pisces).
Halsophis 1894. Amer. Nat., 28: 838. Pro *Alsophis* Fitzinger, 1843.
Haploaspis 1883. PANSP, 35: 13. Pro *Aploaspis* Cope, 1867.

Holarchus 1886. PAPS, 23: 488. Included species "all species with an entire anal plate hitherto referred to *Simotes*." *Simotes formosanus* Günther designated as type by Pope, 1935, Nat. Hist. Cent. Asia, 10: 288.

Hydrocalamus 1885. PAPS, 22: 176. Monotype *Homalopsis quinquevittatus* Duméril and Bibron.

Hypsiglena 1860. PANSP, 12: 246. Designated type *H. ochrorhynchus* Cope, *l. c.*

Ialtris 1862. PANSP, 14: 73. Monotype *I. vultuosa* Cope, *l. c.*

Jaltris, 1893. Amer. Nat., 27: 482. Pro *Ialtris* Cope, 1862.

Letheobia 1869. PANSP, 20 (1868): 322. Included species *L. pallida* Cope, *Onychocephalus caecus* Duméril. We designate *L. pallida* as type.

Lianthera 1893. Amer. Nat., 27: 481. Designated type *Herpetodryas bernieri.*

Lichanura 1861. PANSP, 13: 304. Monotype *L. trivirgata* Cope, *l. c.*

Ligonirostra 1863. Silliman's Journ. (2) 35: 457. Pro *Temnorhynchus* Smith, preoccupied in Coleoptera.

Liodytes 1885. PAPS, 22: 194. Monotype *Helicops alleni* Garman.

Liophallus 1895. PANSP, 46 (1894): 427. Monotype *Dipsas fusca* Gray.

Loxocemus 1861. PANSP, 13: 76. Monotype *L. bicolor* Cope, *t. c.*: 77.

Lystrophis 1885. PAPS, 22: 193. Monotype *Heterodon dorbignyi* Duméril and Bibron.

Manolepis 1885. PAPS, 22: 176. Monotype *Tomodon nasutus* Cope, 1864.

Mesopeltis 1867. PANSP, 18 (1866): 318. Monotype *M. sanniolus* Cope, *l. c.*

Monobothris 1894. Amer. Nat., 28: 841. Monotype *Dromicus chamissonis auct.*

Neomacer 1900. Report U. S. Nat. Mus., 1898: 734. Error for *Uromacer* Duméril and Bibron, 1853.

Nothopsis 1871. PANSP, 23: 201. Monotype *N. rugosus* Cope, *l. c.*

Ocyophis 1886. PAPS, 23: 491. Monotype *Dromicus ater* Gosse.

Ogmius 1870. PAPS, 11: 162. Pro *Oxyrhina* Jan, 1862.

Olisthenes 1860. PANSP, 11 (1859): 296. Monotype *O. euphaeus* Cope, *l. c.*

Ophiomorphus 1862. PANSP, 14: 75. Error for *Opheomorphus* Fitzinger, 1843.

Ophryacus 1887. Bull. U. S. Nat. Mus., 32: 88. Monotype *Atropos undulatus* Jan, 1859.

Pariaspis 1860. PANSP, 12: 241. Monotype *P. plumbeatra* Cope, *t. c.*: 242.

Phalotris 1862. PANSP, 13 (1861): 524. Included species: *Elapomorphus tricolor* Duméril and Bibron, *E. lemniscatus* Duméril and Bibron, *E. reticulatus* Peters, *E. bilineatus* Duméril and Bibron. We designate *E. tricolor* as type.

Phimophis 1860. PANSP, 12: 79. Pro *Rhinosimus* Duméril and Bibron not Latreille.

Phimothyra 1860. PANSP, 12: 253. *Nomen nudum.*

Phimothyra 1861. PANSP, 12 (1860): 566. Pro *Salvadora* Baird and Girard. Preoccupied in botany.

Phrynonax 1862. PANSP, 14: 348. Monotype *Tropidodipsas lunulata* Cope, 1861.

Phyllosira 1862. PANSP, 14: 349. Monotype *P. flavescens* Cope, *l. c.*

Pliocercus 1860. PANSP, 12: 253. Monotype *P. elapoides* Cope, *l. c.*

Pogonaspis 1894. PANSP, 46: 204. Monotype *P. ruficeps* Cope, *l. c.*

Porthidium 1871. PANSP, 23: 209. Included species *lansbergii* Schlegel, *nasutus* Bocourt. We designate *nasutus* as type.

Procinura 1879. PAPS, 18: 262. Monotype *P. aemula* Cope, *l. c.*

Prymnomiodon 1861. PANSP, 12 (1860): 558. Monotype *P. chalceus* Cope, *l. c.*

Rhadinaea 1863. PANSP, 15: 100. Designated type *Taeniophis vermiculaticeps* Cope.

Rhegnops 1866. PANSP, 18: 128. Monotype *R. visoninus* Cope, *l. c.*

Seminatrix 1895. Amer. Nat., 29: 678. Monotype *Contia pygaea* Cope.

Stypocemus 1885. PAPS, 22: 387. Pro *Chilopoma* Cope.

Symphimus 1870. PAPS, 11: 150. Monotype *S. leucostomus* Cope, *l. c.*

Sympholis 1862. PANSP, 13 (1861): 524. Monotype *S. lippiens* Cope, *l. c.*

Synchalinus 1893. PAPS, 31: 345. Monotype *S. corallioides* Cope, *l. c.*

Taeniophallus 1895. TAPS, 18: 201. Monotype *Lygophis nicagus* Cope.

Teleolepis 1870. PAPS, 11: 153. Monotype *T. striaticeps* Cope, *l. c.*

Teleuraspis 1860. PANSP, 11 (1859): 334. Included species: *Trigonocephalus schlegelii* Berthold, *Bothrops castelnaudi* Duméril and Bibron, *Bothrops brachystoma* Cope, *T. lansbergii* Schlegel. We designate *schlegelii* as type.

Theleus 1893. Amer. Nat., 27: 482. Monotype *Boodon virgatum* Hallowell.

Trimerodytes 1895. PANSP, 46 (1894): 426. Monotype *T. balteatus* Cope, *l. c.*

Trimetopon 1885. PAPS, 22: 177. Monotype *Ablabes gracilis* Günther, 1872.
Trimorphodon 1861. PANSP, 13: 297. Designated type *Lycodon lyrophanes* Cope, 1860.
Tripeltis 1886. PAPS, 23: 487. Monotype *Oligodon brevicauda* Günther.
Tropidoclonion 1860. PANSP, 12: 76. Pro *Microps* Hallowell, 1856, nec Megerle, 1823.
Tropidoclonium 1864. PANSP, 16: 167. Pro *Tropidoclonion* Cope, 1860.
Tropidodryas 1885. PAPS, 22: 192. Included species *Hepetodryas aestivus* Schlegel, and *Dryophylax serra* Duméril and Bibron. We designate *T. aestivus* as type.
Tylanthera 1895. TAPS, 18: 205. Monotype *Zamenis florulentus* Geoffroy.
Zaocys 1861. PANSP, 12 (1860): 563. Monotype *Coluber dhumnades* Cantor.

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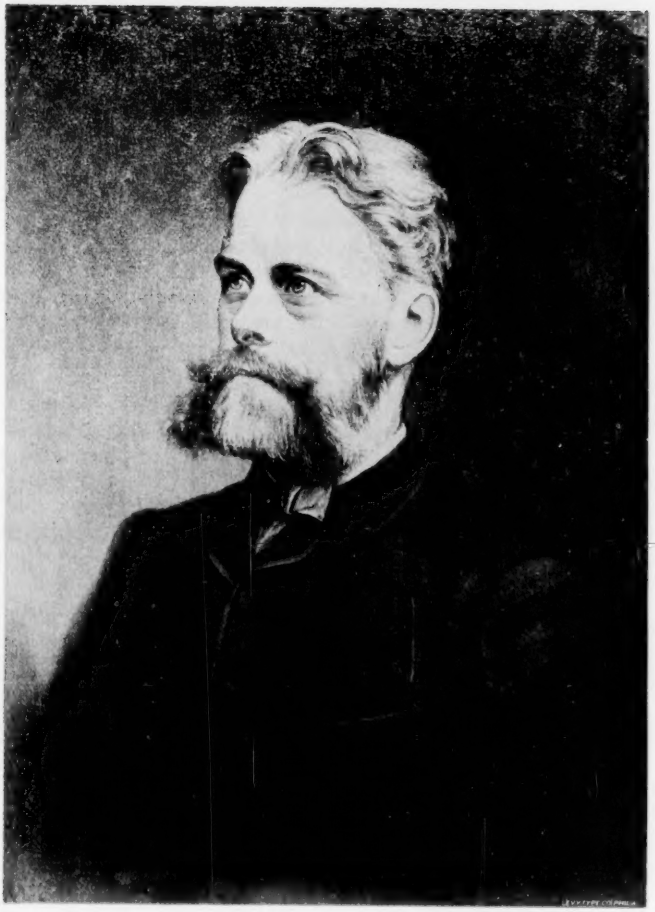
Cope as an Ichthyologist

By GEORGE S. MYERS

TO a modern student, Cope's faunal papers on fishes look strangely antiquated and shot through with peculiar errors. But to understand them we must force ourselves backward into the time when those papers were written, and consider the state in which knowledge then rested. When Cope published his first paper in 1862, only 3 volumes of Günther's "Catalogue of Fishes" were available, and one has only to look at them to realize the condition North American ichthyology was in. In this field the only literature of consequence was Storer's synopsis, DeKay's New York Zoology, Girard's wordy Boundary and Railroad Reports, and the fragmentary short papers of LeSueur, Rafinesque, Mitchill, Kirtland, Agassiz, and Baird. Gill had published a good deal, but he had not worked on the minnows and darters, which form the chief part of the American river fauna. Above all, Cope had no named collections of consequence available to him; his only comparative material was what he himself collected! Viewed in this light, those antiquated papers on the fishes of the Holston, Clinch, Roanoke, Yadkin, Kanawha, and Youghiogheny take on a new meaning. Cope had entered the richest region of speciation in the North American fish fauna, and, over a good part of the area, he was the first naturalist to collect in it. It is a thrill long to be remembered to pull a seine in the upper reaches of the Yadkin, Roanoke, Holston, and James and to see each haul of the net complete a little of the picture of the most gorgeously colored array of fresh-water fishes that is known to exist anywhere on earth. It was to me a still greater thrill to compare my catches with Cope's original diagnoses of them, and finally to realize that those diagnoses formed the first really accurate and concise set of descriptions of North American darters and minnows ever published. The haziness, uncertainty, and wordiness of previous descriptions are replaced by succinct diagnoses and critical appraisals of relationship. Cope's work ushered in a new era in North American fluviatile ichthyology, which was to culminate in Jordan's surveys of the major fish faunas of the country. And even the archaic nomenclature of Cope's papers now looks better than it did twenty



Edw. D. Cope

From an oil painting by George W. Pettit, of Philadelphia, in possession of the American Philosophical Society

UNIV. OF MICH.

years ago, for many of the generic terms then in use have been revived by the critical work of the last few years.

Cope made mistakes, but a great number of the worst ones fade out when examined closely. I could never quite realize why he described the Upper Tennessee form of the green-sided darter, as a new species, until I got my first one from the Clinch. I, too, thought I had a new species until I identified the specimen with Cope's description and, with the benefit of 60 years' more knowledge, realized that it was a very distinctive subspecies of *Etheostoma blennioides*. Cope did not have the comparative material now available.

This brings me to another point. Some of Cope's definite and correct findings in North American ichthyology have become buried under the not-much-better knowledge of a later school, and are only now seeing the light again. The situation is in some ways similar to that in North American herpetology, where, year by year, species after species described by Cope is unearthed from the undeserved synonymy in which a later school of herpetologists had kept it for a generation.

The impatience of meticulous workers with Cope's methods is only human, but some of it impresses me as at least unthoughtful. Cope has been vilified throughout the land for his carelessness with valuable specimens, which (one would suppose) he almost always (1) lost, (2) dissected, (3) untagged, or (4) mixed with others; and because of this has been held up as a horrible example whose ways meticulous young systematists should shun. This irks me no end. The writer is the last one to condone carelessness with types, and after long experience tracking down a large number of the early specimens of Girard and Jordan, he believes he is familiar with most of the exasperating things that can happen to type specimens. It is true that Cope was careless with his specimens. But it is also true that he was the only available man competent to handle most of the material that came to him, and he utilized this material with a thoroughness and brilliance that few subsequent investigators have equalled. An extraordinary quantity of specimens came to him continually, which he was obliged to care for without assistance. Small wonder then that he suffered the fault of spreading this care a little thin!

Cope's work as an ichthyologist does not rank with his herpetological contributions. Among ichthyologists, Gill, and later Goode, T. H. Bean, Jordan, and Gilbert were his contemporaries, and to them he left the recent fishes. His most important ichthyological papers were nearly all published within five years, 1868-72. During this period appeared his chief contributions to the ichthyology of the eastern states, his more important papers on the fishes of the Amazon, and his brilliant reclassification of the recent teleosts, based upon the great Hyrtl collection of skeletons. Later, he became more and more absorbed in paleontological studies, and although several more contributions on recent fishes appeared, he did not re-enter the field in a major way. Cope also did much with the recent and fossil fish faunas of the interior drainages of the western states, as a by-product of his numerous fossil-hunting expeditions. A proper evaluation of this work has yet to be made, since it will become possible only upon the completion of Dr. Hubbs' extensive investigations of this fauna.

Gill has already summarized the contribution Cope made to a knowledge

of the interrelationships of the fishes as a whole. His critique, a rather coldly critical document, does not emphasize many of Cope's discerning improvements in the system. Cope more than dimly perceived (perhaps for the first time) the major importance of the Weberian apparatus in defining the groups later combined into the order Ostariophysi, and he correctly placed the "Ostracoderms" as cyclostomes, a strikingly lucky guess. Cope early recognized the peculiar distinctness of the eels and was the first to show that the Gymnotids were allied to the Carps and Characins, even though he erred in placing *Gymnotus* itself elsewhere. Although it is now of little importance, it is possible that certain of his errors in this field were due to the condition or mislabelling of some of the Hyrtl skeletons, which more recent work has shown could not always be depended upon.

I have said elsewhere (review of Cope: Master Naturalist, COPEIA, 1932, No. 1: 39) that Cope's papers on the fishes of the Peruvian Amazon are still the most extensive on the immense fish fauna of that region, although more comprehensive work is now in prospect. In view of the difficulty of interpreting Cope's descriptions of certain of these fishes, it is interesting to note the observations of Mr. W. A. Gosline, who has recently examined some of the types at Philadelphia. Mr. Gosline reports that many of the specimens were apparently preserved in some peculiar fixing agent to which copper sulphate had been added, and were evidently in very poor condition when Cope received them.

It is impossible for the writer to do more than call attention to the extent and importance of Cope's contributions to paleichthyology. Dr. Gregory has already done this in the Osborn biography. Cope's work on recent fishes alone would entitle him to respect as one of our foremost scientists, and when one adds to this his enormous contributions to herpetology and paleontology, one begins to understand why Osborn has called him the Master Naturalist.

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Rediscovery and Redescription of *Pariolius armillatus*, a Genus and Species of Pimelodid Catfishes Described by E. D. Cope from the Peruvian Amazon in 1872

By W. A. GOSLINE

THE genus and species *Pariolius armillatus* may be said to have had an unfortunate history. The fish was described in 1872 by Cope from the Ambyiacu (more commonly Ampiyacu) River, a tributary entering the Peruvian Amazon from the north at Pevas. Due to the undoubtedly poor condition of the specimen and the state of knowledge at that time, certain charac-

ters which have since been shown to be important in the classification of South American catfishes were omitted from the description. Cope made the further natural error of grouping *Pariolius* with the trichomycterids—(=pygidiids), a group at that time poorly differentiated and diagnosed. To complete the cycle of misfortune, the type specimen in the Philadelphia Academy of Natural Sciences has become mislaid or lost. Nor were further specimens of the species collected for over sixty years.

During this time the status of *Pariolius* has been decidedly indefinite. It has usually been left as a provisional genus in the Pygidiidae, though Eigenmann, 1918 (see synonymy under specific description), has correctly interpreted its relationship with the pimelodids. Because of his uncertainty of relationship, further material containing this fish, collected at approximately the type locality on the Ampiyacu by Mr. W. G. Scherer, is more than welcome. The collection, of which the specimens of *Pariolius* have been described below, has been kindly turned over to me for study by Prof. G. S. Myers.

Pariolius Cope

Pariolius Cope, 1872, Proc. Acad. Nat. Sci. Philadelphia (1871), 24: 289 (genotype by monotypy *Pariolius armillatus* Cope).

Nannoglanis Boulenger, 1887, Proc. Zool. Soc. London for 1887: 278 (genotype by monotypy *Nannoglanis fasciatus* Boulenger).

Head flattened, snout not produced. Four mental and two maxillary barbels, not flattened. No nasal barbels. Teeth in both jaws in a villiform band, that of the upper jaw without backward projecting angles at the sides. No vomerine teeth. Distance between anterior and posterior nares slightly greater than the diameter of the eye, the four nares forming almost a perfect square. Eye small, covered with skin, with no free margin. Fontanel not visible externally. Temporal regions of head with a layer of muscle below the skin, which does not cover the central area. Occipital process short. Dorsal and pectoral spines entirely absent. Ventral bases slightly in advance of dorsal, well forward of center of body. Adipose fin long, low, not connecting with caudal. Pectorals and ventrals short, rounded. Anal short, of eight to ten rays. Caudal obliquely rounded or truncate.

Of the five pimelodid genera besides *Pariolius* without a free orbital rim and without dorsal or pectoral spines, *Pariolius* may at once be separated from *Heptapterus* Bleeker, 1858, *Acentronichthys* Eigenmann and Eigenmann, 1889, and *Rhamdiopsis* Haseman, 1911, by the longer anal fin (18 to 28 rays) in the last three genera. From *Chasmocranus* Eigenmann, 1912, *Pariolius* differs in having a narrower series of premaxillary teeth without backwardly projecting angles at the sides and from *Cetopsorhamdia* Eigenmann, 1916, in lacking a forked caudal and in having the ventral fins placed forward of the dorsal. *Nannoglanis* is here considered a synonym of *Pariolius*.

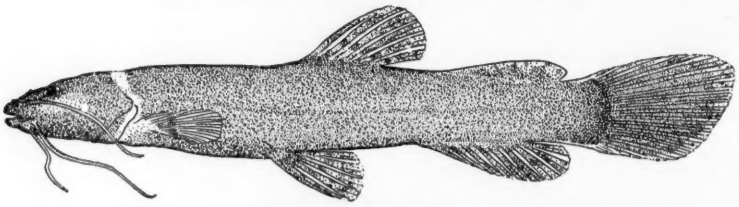
One species has been attributed to *Pariolius* and three to *Nannoglanis*. One of these, *Nannoglanis hoehnei* Miranda Ribeiro, 1914, is a *Pimelodella*-like fish which certainly does not belong here. The remaining three species are known from the Ampiyacu, eastern Ecuador, and São Paulo respectively.

Pariolius armillatus Cope

Pariolius armillatus Cope, 1872, Proc. Acad. Nat. Sci. Philadelphia (1871), 24: 289; Eigenmann and Eigenmann, 1889, Proc. California Acad. Sci., (2) 2: 50 (name only); Eigenmann and Eigenmann, 1890, Occ. Pap. California Acad. Sci., 1: 317 and 324 (copied from Cope); Eigenmann and Eigenmann, 1891, Proc. U. S. Nat. Mus., 14: 36 (name only); Eigenmann, 1910, Reports Princeton Univ. Exped. to Patagonia, 1896-1899, 3 (4): 398 (name only); Eigenmann, 1918, Mem. Carnegie Mus., 7 (5): 260 (discussion of relationships).

Material: 12 specimens, 13-34 mm. in standard length, collected in the vicinity of Pevas, Peru, in 1936 and 1937, and deposited in the Natural History Museum of Stanford University.

The following measurements are only for the three largest specimens, 31 to 34 mm. in standard length. Where the proportions of the figure and those of the description disagree, preference should be given to the description.



Pariolius armillatus

Drawn by Helen K. Nojiri from Stanford 34171, 28 mm. in standard length; Shansho Caño, Pevas district, eastern Peru.

Depth 7.2-7.5 in standard length, head measured to end of opercle 4.1-4.3. Head broad, its width 1.3 in its length. Maxillary and outer pair of mental barbels reaching about two-thirds of the way along pectoral fins; inner pair of mental barbels about to end of opercle. Eye small, contained 5.6-6.5 in head; snout 2.4-2.7; interorbital 3.0-3.5. Distance between snout and dorsal contained 2.1 in standard length, between snout and ventral bases 2.2-2.4. Dorsal with six or seven rays, its base contained 8.5-10.4 in standard length, its distance from adipose 5.2-5.6. Adipose base contained 4.8-5.3 in standard length. Anal with nine rays, commencing below a point about midway between dorsal and adipose. Pectorals reaching about two-thirds of the distance from their bases to the ventrals; ventrals about half the distance from their bases to the anal. Caudal obliquely rounded, the upper section the longer. The color has been well described by Cope as follows: "dark brown, nearly black on the top of the head; under surfaces from anus brownish yellow, brown punctulate. A broad yellow collar extends from the under surface on each side across the bases of the pectoral fins and the vertex. A vertical dark spot on base of caudal (indistinct in Scherer's specimens); fins brown-spotted."

This species may be most readily distinguished from the other two species of the genus, *Pariolius fasciatus* (Boulenger), 1887, and *Pariolius bifasciatus* (Eigenmann and Norris), 1900, by its striking color pattern.

Natural History Museum, Stanford University, California.

Suppression of Two Generic Names (*Auchenopterus* and *Cremnobates*) of Tropical American Blennioid Fishes, with Notes on Systematic Characters

By Margaret Storey

GÜNTHER (1861: 275) proposed *Auchenopterus* as a genus of blennioid fishes. Under it he included a new species, *A. monophthalmus*, and doubtfully another species, *Clinus veranyi* of Filippi and Verany. The *International Rules of Zoological Nomenclature*, Article 30e, expressly exclude *species inquirendae* from consideration in determining the types of genera. *A. monophthalmus* Günther (Pacific coast of Central America) is therefore the type of *Auchenopterus* Günther by monotypy (and not by original designation, or orthotypy, as stated by Jordan, 1919: 307). In April, 1862, Günther (page 374) decided that *Auchenopterus* was preoccupied, and substituted the new name *Cremnobates*, which perforce takes the same generic type as *Auchenopterus*. Undoubtedly, as Jordan states (1919: 308), Günther made this change because of the similarity to *Auchenipterus* Cuvier and Valenciennes (1840: 207), a genus of catfishes. However, according to the *Rules*, Article 36, Recommendations, *Auchenopterus* is not necessarily to be rejected as a homonym of *Auchenipterus*.

But Agassiz (1846: 40) had already emended *Auchenipterus* of Cuvier and Valenciennes to *Auchenopterus*, long before Günther's proposal of his *Auchenopterus*. This case is exactly parallel to that of *Borus vs. Boros*, in which the nomenclatural aspect of Agassiz's nomenclatorial emendations is discussed by the International Commission on Zoological Nomenclature (1936: 3, Opinion 125). In compliance with the decision of the Commission, *Auchenopterus* Günther, 1861, must be suppressed as an absolute homonym of *Auchenopterus* Agassiz, 1846 (=*Auchenipterus* Cuvier and Valenciennes, 1840).

It now appears that *Cremnobates* Günther, 1862, is also an unusable synonym. Both Schulze (1928: 824) and Neave (1939: 867) list *Cremnobates* Swainson (1855: 43), a mollusc. I have verified this reference, and the fish name *Cremnobates* falls as an absolute homonym of the mollusc name *Cremnobates*, currently in the synonymy of *Marinula* King, 1831 (Thiele, 1929: 464). Another name must be found for this genus of blennioid fishes, or a new name proposed. This involves consideration of the limits of the genus.

In the absence of any recent real revisional work on this group of blennies it is difficult to decide just what forms are to be included in "*Auchenopterus*" of authors. Günther, in his key to the genera of the family Blenniidae (1861: 207), uses "Dorsal fin formed of spines only" and "Two dorsal fins" to identify his new genus *Auchenopterus*. These characters are repeated in both generic and specific descriptions (page 275). He states that the anterior fin is

composed of three spines, that "the membrane behind the third spine extends backwards to the base of the second fin," and that "the membrane of the last spine terminates immediately before the base of the caudal." Two succeeding descriptions by Günther (1862: 374; 1868: 442) under the substitute generic name *Cremnobates* are virtual reprints of the original, while the figure (1868: plate 69, fig. 1) not only sheds no light on the structure of the vertical fins, but is perhaps not of the type, since Günther reports (1864: 25) the receipt of additional specimens from Captain Dow in the meantime. Although succeeding authors who have discussed Günther's species *monophthalmus* disagree on the character of the notch in the dorsal fin, it is notable that they unanimously record the presence of an articulated soft ray at the posterior end of that fin, and always without comment.

Mocquard's descriptions of his new genus and species, *Acanthoclinus chaperi* (1886: 18), are unfortunately based on a single small specimen, from Guanta Bay, near Barcelona, Venezuela. He makes no mention of Günther's genus, comparing his *Acanthoclinus* (=*Paraclinus* Mocquard, 1889: 41, footnote) directly only with *Clinus*. He emphasizes by repetition that the dorsal fin is "*entièrement épineuse*," adding that it is "*très long, simple.*" His second generic character, that the lateral line "*présente un interruption*," has been ignored, probably rightly, by succeeding authors, since it is frequently difficult to trace the curved portion of the lateral line in specimens of this group. For example, in Meek and Hildebrand (1928: plate 93, fig. 1), the artist clearly shows an interrupted lateral line in *Auchenopterus affinis*, the text to the contrary notwithstanding. Metzelaar (1919: 156) is apparently the only worker to have had at hand a quantity of specimens of *Paraclinus chaperi*. His material is from Aruba and Curaçao, 350 and 400 miles from the type locality. His fin-formula is "D. XXIX–XXX; A. II, 18–19" (Mocquard gives: D. 31; A. 2/19), and he notes: "The 4 anterior dorsal spines wider apart and gradually lower than the others, but as a rule no evident notch, which is, however, sometimes distinct." The description and figure agree well enough with Mocquard's original account, but Metzelaar's artist, despite the text, has drawn the dorsal showing five spines anteriorly, followed by 25 obviously branched, articulated rays. The artist is evidently badly in error. Metzelaar refers six specimens from Curaçao to *Auchenopterus affinis* (Steindachner) (1877: 226), commenting that they are "Much alike to *Paraclinus chaperi*, but easily distinguished from that species by the *one* soft dorsal ray, the deep notch in the dorsal fin, and the more acute and elevated form of the head."

Nichols (1922: 69) identifies two specimens, which lack a dorsal ray, with *Cremnobates fasciatus* Steindachner (1877: 224, from the same locality as *C. marmoratus*, see later), because Steindachner, in his original description "does not specifically mention the soft ray. . . . This difference seems of generic value, and there being apparently no generic name available for it"—he proposes the new generic name *Tekla*.

Hildebrand and Ginsburg (1926: 213, fig. 4) identify their seven specimens as *fasciatus* because they lack a dorsal ray and "seem to agree with descriptions of that species. . . . However, we do not feel absolutely certain about this identification." Without mention of Nichols' disposition of the

same species (see above), they refer *fasciatus* to *Paraclinus*. They are the first to point out that the intraspecific variability of the character of the dorsal notch makes it useless for generic separation; but they feel that the presence or absence of a dorsal ray is probably constant within the species, and that therefore *Auchenopterus* and *Paraclinus* "may conveniently be separated by that character."

Jordan (1884: 142) gives a key to the six species of *"Cremnobates"* then known. Later, Jordan and Evermann (1898: 2369) revise this key, add two species, and call the whole group *Auchenopterus*. The primary separation within the genus remains the same in the two keys. For the species included in the first category: "a. First 3 or 4 spines of the dorsal forming a separate fin, being much higher than any of the spines in the posterior part of the fin; snout rather acute," Jordan and Evermann propose the subgeneric name *Corallicola,* leaving in *Auchenopterus sensu strictu* the species placed under: "aa. First 3 spines of the dorsal scarcely forming a separate fin, none of them higher than the posterior spines; snout not very acute; anal without ocellus." *Cremnobates marmoratus* Steindachner (1877: 222), from a rocky island north of Cuba, is genotype by original designation of *Corallicola*. They grant *Paraclinus* (page 2374) full generic separation from *Auchenopterus* on the basis of the continuous dorsal fin, "a character which needs verification."

Although several others, including Rosa Smith (1880: 147), Gilbert (1904: 269), Metzelaar (1919: 157), and Meek and Hildebrand (1928: 931) have noted intraspecific variation in the outline of the dorsal fin in species of this group, Hildebrand and Ginsburg, as stated above, are apparently the first to point out that this renders the character useless for generic (and, of course, specific) separation.

Unfortunately, the only generic character so far proposed that remains (the presence or absence of a soft ray in the dorsal fin) can be shown to be equally useless, and for the same reason. I have at hand a number of series, in bottles, of specimens belonging to several nominal species of this group from the Atlantic and Pacific shores of the Americas. In seven such lots, all of them consisting of species with a posterior dorsal ray normally present, one or more of the specimens either completely lack this ray, or possess it in such an abbreviated form that it is visible only under strong transillumination or manipulation; it shows no evidence of articulations, and sometimes barely reaches to the fin membrane. In two cases this "spicule" runs along the base of the fin membrane, parallel with the dorsal body outline, and must be teased out to be seen. There is considerable evidence of intra- as well as interspecific variation in the robustness of the ray, even when it is otherwise well developed. Frequently, although it extends to the margin of the membrane, the ray lies so close against the adjacent spine that it is easily missed. In five specimens from Garden Key, Florida (Stanford 8183), similar in other respects, I find that one has a strong dorsal ray, two have a feeble ray, one has a "spicule," and one shows no evidence whatever of a dorsal ray. A generic character cannot be "usually" or "often" present.

It is quite possible that Günther (*monophthalmus*), Steindachner (*marmoratus,* etc.) and other authors actually missed a feeble dorsal ray in the

heavily pigmented membrane, or that their descriptions are based on single, aberrant specimens. The ray is often difficult to see, even when developed, as noted by Evermann and Marsh (1899: 361) and Beebe and Tee-Van (1928: 228). Unquestionably there are species in this group with the dorsal ray normally absent. In a lot (Stanford 9894) labeled *Auchenopterus integripinnis* (Rosa Smith, 1880: 147), from the type locality, San Diego, California, none of the thirty-eight specimens shows the slightest evidence of a dorsal ray. This is in accord with the original description: "D. XXXII." Jordan and Evermann (1898: 2372) wrongly give for this species the fin-formula D. III–XXVII, 1, and wrongly describe and key it accordingly.

As Hildebrand and Ginsburg suggest, a careful revision, including a study of the types and ample material, is urgently needed. The reviser must place his dependence upon the types rather than the original descriptions, and must be particularly suspicious of subsequent identifications and descriptions. Typographical errors (of which there are many) aside, it is the exception to find two descriptions of a given species in agreement.

Sufficient study will undoubtedly unearth a number of valuable systematic characters, including, perhaps, the dentition and the structure and number of gill-rakers; and will, on the other hand, eliminate some hitherto highly regarded ones. Although several authors, including Gilbert (1904: 269), Gilbert and Starks (1904: 189), Meek and Hildebrand (1928: 933), and, by implication, Longley (1933: 294), note the presence of certain sexual differences in this group, no one, so far as I am aware, has realized their importance. I feel that little progress can be made toward a revision until the sexual dimorphism has been studied. But it is entirely possible that *almost no fully adult specimens of any species have been collected,* and the sexual differences are not striking in immature specimens.

Through the kindness of Dr. Charles M. Breder, Jr., a fine collection of specimens of *marmoratus* has been made available to me for a proposed study. These fishes were collected at various times of year and from several habitats by Mr. M. B. Bishop of Peabody Museum, Yale University, working at the laboratory of the New York Aquarium on Palmetto Key, in the Pine Island Sound-Charlotte Harbor region of southwest Florida. The specimens came to me in several shipments. There were forty specimens in the first lot, collected in July and August, from beds of "eel-grass" and the marine growth on dock pilings. The specimens, which average 40.7 mm. in total length, are comparable in size to most of the holotypes of the species of this group (mean about 41 mm.), to material used in later reports, and to specimens in the Stanford Natural History Museum collection. There was nothing about these fishes to suggest immaturity; sexual differences were present, but slight and in accord with the records cited above for other species of this group. The identification seems reasonably certain (Steindachner's figure evidently represents a large, immature male). The next lot proved most surprising. The specimens had been taken in March, the females while spawning, the males while guarding the eggs, in "nests," usually in old, partly broken sponges according to Breder (1939), who reports on the life history and development of this species. The nineteen breeding adults average 72.9

mm. in total length. Another lot, received since but collected a month earlier in the same Pelican Bay sponge beds, contains fourteen slightly smaller specimens (mean length 69 mm.), apparently mostly in pre-spawning condition. Not only are the thirty-three February-March specimens very much larger than the July-August ones, but in these unquestionably mature fishes the sexual dimorphism is most striking. The females show on the whole a persistence of the characters found in the immature specimens of both sexes; *but the males, on the basis of systematic characters hitherto used, appear to belong to a different species, if not to another genus!* I hope to report on these differences in detail later. So far as I am aware, these are the first mature specimens of the species to be collected. They were secured only in the breeding locality during breeding season. The fishes collected elsewhere were immature, and much smaller. This indicates migration of some sort, and perhaps death after spawning, as Breder suggests.

If these findings hold true for even a few other species of this group they will help to explain some of the confusion, and point a way toward a solution. It is my opinion that a number of nominal species will disappear into the synonymy when growth stages up to and including breeding adults are studied. At the very least, the reviser must assure himself that he has adult material, with both sexes represented. And apparently the collector must be in the right place at the right time to secure them.

For the present, the generic limits set forth by Jordan and Evermann (1898: 2369) for *Auchenopterus* are adequate for this clinid group, except that "mouth moderate" must be deleted, and the second sentence should read: Dorsal fin composed of spines, or with but a single soft ray posteriorly; first 3 or 4 spines wider set and sometimes higher than the others, frequently followed by a notch of varying depth. *Paraclinus* of Jordan and Evermann falls within this definition and is included, and its name stands for the group. The synonymy of the genus will appear as follows:

Paraclinus Mocquard, 1889

Auchenopterus (*nec Auchenopterus* Agassiz, 1846, a catfish) Günther, 1861: 275 (genotype by monotypy *A. monophthalmus* Günther, 1861).

Cremnobates (*nec Cremnobates* Swainson, 1855, a mollusc) Günther, 1862: 374 (substitute for *Auchenopterus* Günther, 1861; same type).

Acanthoclinus (*nec Acanthoclinus* Jenyns, 1841, a blenny) Mocquard, 1886: 18 (genotype by monotypy *A. chaperi* Mocquard, 1886).

Paraclinus Mocquard, 1889: 41 (substitute for *Acanthoclinus* Mocquard, 1886; same type).

Corallicola Jordan and Evermann, 1898: 2369 (genotype by original designation *Cremnobates marmoratus* Steindachner, 1877).

Tekla Nichols, 1922: 69 (genotype by monotypy *Cremnobates fasciatus* Steindachner, 1877=*?Acanthoclinus chaperi* Mocquard, 1886).

Paraclinus chaperi is thus the genotype. The nominal forms of this genus follow, with the type locality of each and number of specimens upon which the original description was based:

1. *Paraclinus monophthalmus* (Günther, 1861), Pacific coast of Central America, 1 specimen.
2. *Paraclinus nigripinnis* (Steindachner, 1867), Barbados, 1 (?).
3. *Paraclinus marmoratus* (Steindachner, 1877), island north of Cuba, 1.
4. *Paraclinus fasciatus* (Steindachner, 1877), same as *marmoratus*, 2 (?).

5. *Paraclinus affinis* (Steindachner, 1877), St. Thomas, Virgin Islands, 1.
6. *Paraclinus integripinnis* (Rosa Smith, 1880), San Diego, California, 3.
7. *Paraclinus altivelis* (Lockington, 1882), La Paz, Lower California, 1.
8. *Paraclinus nox* (Jordan and Gilbert, 1884), Key West, Florida, 1.
9. *Paraclinus chaperi* (Mocquard, 1886), Guanta Bay, Venezuela, 1.
10. *Paraclinus albicaudus* (Evermann and Marsh, 1899), Arroyo, Puerto Rico, 1.
11. *Paraclinus rubescens* (Evermann and Marsh, 1899), Puerto Real, P. R., 1.
12. *Paraclinus cingulatus* (Evermann and Marsh, 1899), Ponce, P. R., 5.
13. *Paraclinus fajardo* (Evermann and Marsh, 1899), Fajardo, P. R., 1.
14. *Paraclinus mexicanus* (Gilbert, 1904), La Paz, Lower California, 5.
15. *Paraclinus grandicomis* (Rosén, 1911), Andros Island, Bahamas, "several".
16. *Paraclinus rubicundus* (Starks, 1913), Natal, Brazil, 1.
17. *Paraclinus argus* (Beebe and Tee-Van, 1928), Port-au-Prince Bay, Haiti, 1.
18. *Paraclinus ocellatus* Howell Rivero, 1936, Havana, Cuba, 1.

American species only are considered here. I have seen no convincing record for this genus in the eastern hemisphere.

Literature Cited

Agassiz, John Louis Rodolphe
1846 Nomenclator Zoologicus, Index Universalis, etc. Soloduri: viii+393.

Beebe, William, and John Tee-Van
1928 The fishes of Port-au-Prince Bay, Haiti, with a summary of the known species of marine fish of the Island of Haiti and Santo Domingo. *Zoologica,* 10 (1): 1–279, figs.

Boeke, J.
1919 Rapport betreffende een voorloopig onderzoek naar den toestand van de Visscherij en de Industrie van Zee producten in de Kolonie Curaçao, ingevolge het Ministerieel Besluit van 22 November 1904. Vol. 2: xxxiv+348+3. Gedrukt op last van den Minister van Koloniën bij F. J. Belinfante, 's-Gravenhage.

Breder, Charles Marcus, Jr.
1939 On the life history and development of the sponge blenny, *Paraclinus marmoratus* (Steindachner). *Zoologica,* 24 (4): 487–496, 3 figs., 4 pls.

Cuvier, Georges, and Achille Valenciennes
1840 Histoire Naturelle des Poissons. 22 vols., atlas. Paris, 15, livre 17: xxi+540+2.

Evermann, Barton Warren, and Millard Caleb Marsh
1899 Descriptions of new genera and species of fishes from Puerto Rico. *Rept. U. S. Commissioner Fish,* 25: 351–362.

Gilbert, Charles Henry
1904 Notes on fishes from the Pacific coast of North America. *Proc. Calif. Acad. Sci.* (3) 3 (9): 255–271, pls. 24–29.

Gilbert, Charles Henry, and Edwin Chapin Starks
1904 The fishes of Panama Bay. *Mem. Calif. Acad. Sci.,* 4: 1–304, 33 pls.

Günther, Albert Carl Ludwig Gotthilf
1861 Catalogue of the fishes of the British Museum. In 8 vols., 1859–1870. London, 3: xxvi+586+x.
1862 On a collection of fishes sent by Capt. Dow from the Pacific coast of Central America. *Proc. Zool. Soc. London* (1861): 370–376, fig. Issued separately: 1–7.
1864 On some new species of Central-American fishes. *Ibidem* (1864): 23–27, 2 pls. Issued separately: 1–5.
1868 XIV. An account of the fishes of the states of Central America based on collections made by Capt. J. M. Dow, F. Godman, Esq., and O. Salvin, Esq. *Trans. Zool. Soc. London,* 6 (7): 377–494, pls. 63–87.

Hildebrand, Samuel Frederick, and Isaac Ginsburg
1926 Descriptions of two new species of fishes from Key West, Fla., with notes on nine other species collected in the same locality. *U. S. Bur. Fisheries, Bull.* 42: 207–215, 5 figs.

INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE
1936 Opinions No. 124–133. *Smithsonian Misc. Coll.*, 73 (8): 1–44.

INTERNATIONAL RULES OF ZOOLOGICAL NOMENCLATURE
1926 *Proc. Biol. Soc. Washington*, 39: 75–103.

JORDAN, DAVID STARR
1884 List of fishes collected at Key West, Florida, with notes and descriptions. *Proc. U. S. Nat. Mus.*, 7: 103–150.
1919 The Genera of Fishes, 1758–1920, with the accepted type of each. A contribution to the stability of scientific nomenclature. In 4 parts. *Leland Stanford Jr. Univ. Publs., Univ. ser.*, part 3, from Guenther to Gill, 1859–1880, twenty-two years: 283–410+xv.

JORDAN, DAVID STARR, and BARTON WARREN EVERMANN
1898 The fishes of North and Middle America, etc. In 4 parts, 1896–1900. *U. S. Nat. Mus. Bull.* 47 (3): xxiv+2183–3136.

LONGLEY, WILLIAM HARDING
1933 Preparations of a monograph on the Tortugas fishes. *Carnegie Inst. Washington Yearbook*, 1932–1933, 32: 293–295.

MEEK, SETH EUGENE, and SAMUEL FREDERICK HILDEBRAND
1928 The marine fishes of Panama. In 3 parts. *Field Mus. Nat. Hist., Zool. ser.*, 15 (3), publ. 249: xxv–xxxi, 709–1045, pls. 72–102.

METZELAAR, JAN
1919 Report on the fishes, collected by Dr. J. Boeke, in the Dutch West Indies, 1904–1905, with comparative notes on marine fishes of Tropical West Africa. *In:* Boeke, J., 1919: 1–315, which see. [Metzelaar's paper also appeared separately as a thesis of Amsterdam University under the title: Over tropisch Atlantische Visschen.]

MOCQUARD, F.
1886 Sur un nouveau genre de Blenniidae voisin des *Clinus (Acanthoclinus)*. *Bull. Soc. Philomat. Paris*, (7) 10, (1885–1886): 18–20. Also issued separately: 1–3.
1889 Révision des *Clinus* de la collection du Museum. *Ibidem* (1888) (8) 1 (1): 40–46.

NEAVE, SHEFFIELD AIREY
1939 Nomenclator Zoologicus, 1758–1935. In 4 vols. London. Vol. 1, A–C: xiv+957.

NICHOLS, JOHN TREADWELL
1922 *Tekla*, a new genus of blennies, and other notes. COPEIA, 1922 (110): 67–69.

SCHULZE, F. E., W. KÜKENTHAL, and K. HEIDER; R. HESSE, *ed.*
1928 Nomenclator animalium generum et subgenerum. Berlin, 1926—. Vol. 2, C–E (1929): 477–1298. Lief. 8:797–956.

SMITH, ROSA
1880 On the occurrence of a species of *Cremnobates* at San Diego, California. *Proc. U. S. Nat. Mus.*, 3: 147–149.

STEINDACHNER, FRANZ
1867 Ichthyologische Notizen (VI). vii. Über einige neue oder seltene Fischarten von Westindien und Surinam. *Sitzb. Akad. Wiss. Wien*, 56, Abth. 1: 347–357. Issued separately: 41–51.
1877 Ichthyolologische Beiträge (V). v. Über einige neue oder seltene Fischarten aus dem atlantischen, indischen und stillen Ocean. *Ibidem*, 74, Abth. 1: 203–240. Issued separately: 155–192.

SWAINSON, WILLIAM
1855 On the characters of several amphibious Volutes allied to the genus *Melampus*. *Proc. Royal Soc. Van Diemansland* [=Tasmania], 3, fasc. 1: 42–46, pl.

THIELE, JOHANNES
1929 Handbuch der systematischen Weichtierkunde. Jena: 1–778, 783 figs.

NATURAL HISTORY MUSEUM, STANFORD UNIVERSITY, CALIFORNIA.

Superfetation in Viviparous Cyprinodont Fishes

By C. L. Turner

ALTHOUGH viviparity is the rule in the marsupial and placental mammals and occurs also in some reptiles and selachians, superfetation does not take place. The ovocytes reach maturity seasonally or periodically within the ovarian follicles, after which ovulation occurs. The ova enter the oviducts where fertilization takes place and the developing embryos are then retained in the oviduct or uterus for the period of gestation. In the mammals, at least, the implantation of the embryos in the uterus brings about changes in the endocrine control of ovulation and the cyclical changes in the uterus with the result that ovulation does not occur during gestation and the cyclical changes in the uterus which proceed in the absence of fertilization of the ovum are held in abeyance. In the viviparous reptiles and selachians large yolk-laden eggs are developed seasonally. After ovulation the ova are drawn into the oviducts where they are fertilized and the embryos are then retained in the oviducts during the period of gestation. In the meantime new ovocytes are developing in the ovary but they do not become mature by the end of the gestation period. Some time elapses, therefore, between the birth of one group of embryos and the ovulation and fertilization of the ova which are to form the next brood.

In the viviparous hemirhamphid, embiotocid and cyprinodont fishes, different relations exist. There is no true oviduct in these fishes. Instead, a short unpaired gonaduct connects the cavity of the ovary with the genital pore. Ovocytes develop to maturity in the ovarian follicles. The mature ova are fertilized within the follicles by sperm which, after reaching the ovarian cavity through the genital pore and gonaduct, penetrate the wall of the ovarian cavity and the wall of the ovarian follicle. In the hemirhamphid fishes and in the families Anablepidae and Poeciliidae of the cyprinodont fishes, the developing embryos are not evacuated from the ovarian follicles during gestation but are retained in the same site in which they are fertilized while the walls of the follicles become more or less modified. In the embiotocid fishes and the families Jenynsiidae and Goodeidae of the cyprinodont fishes, the embryos are evacuated during the early segmentation stages from the ovarian follicles into the ovarian cavity where they are retained during gestation. The ovary in all of these fishes has the two-fold function of elaborating ova from the ovigerous tissue and of harboring the embryos during gestation. The ovary is modified to some extent during gestation to provide the embryos with respiratory materials. In these species the yolk is reduced in amount and the ovary becomes more elaborately specialized to provide a nutritive supply. The structural and functional modification of the ovary incident to the retention and nourishing of the embryos seems to have little effect upon the development of the ovocytes, and the production of mature ova proceeds independently. In the embiotocid fishes there is an annual cycle in which new mature ova are not produced for some months

after the embryos are evacuated from the ovary. Some of the viviparous cyprinodont fishes, however, have short reproductive cycles, in some instances of only one month's duration, and new ova are ready for fertilization before the previous brood is born. Many of the mature ova become atretic but sometimes they become fertilized and a second brood of embryos will be found in the ovary. Potential superfetation exists wherever mature ova are formed by an ovary in which a brood of embryos is retained and within which there are viable sperm.

Superfetation results from the following combination of factors: (1) The independent process of differentiation of ovocytes and maturation of the ova in an ovary which is already gravid. (2) Fertilization of the ovum within the ovarian follicles, making it unnecessary for ovulation to intervene. (3) Short, often-repeated reproductive cycles in which maturation of new ova overlaps the previous gestation period. (4) The reproductive behavior of the female providing for receptivity to the male while the female is still gravid. (5) The almost continuous production of sperm in the testis of the male and readiness of the male to copulate at any time, or (6) the capacity of the ovary to store viable sperm over long periods of time.

The complete combination of factors is lacking in the embiotocid fishes in which reproduction is seasonal. In the hemirhamphid fishes, at least in *Dermogenys pusillus,* all factors are present except that the full differentiation of ovocytes and the maturation of new ova do not overlap the gestation period. In the viviparous cyprinodont fishes incipient or effective superfetation has been found in three families (Poeciliidae, Goodeidae, Jenynsiidae) and may possibly exist in the fourth family (Anablepidae) although a preliminary study based upon insufficient material reveals no superfetation in this family.

Poeciliidae.—In most of the genera of this family there is no superfetation (Turner, 1937). Broods of embryos are born before the next groups of ovocytes are fully differentiated. In *Poeciliopsis infans, P. balsas, P. fasciata, Poecilistes lutzi, P. pleurospilus, Dextripenis evides, Flexipenis vittata* and probably in *Pseudopoecilia fria, Diphyacantha chacoënsis* and others the ova become mature and are fertilized while the gestation period of the previous brood is still in progress so that two broods of embryos at different stages of development may occur in the ovary at the same time. Pronounced types of superfetation have been evolved in *Heterandria formosa,* in several undescribed and unnamed species of *Poeciliopsis* and *Poecilistes* and also in *Aulophallus retropinna* and *A. elongatus.* As many as nine separate broods may occur in the ovary simultaneously in the most specialized instances.

The beginning of superfetation in poeciliid fishes does not seem to be associated with smaller yolk sacs since the yolk sacs in most of the species with simple superfetation are about as large as those of fishes in which superfetation does not occur. Extreme superfetation is found in those species in which the yolk sac has decreased in size and special devices have been evolved in the embryos and the follicular capsules (follicular pseudoplacentae) for facilitating the exchange of food, waste, and respiratory materials between the embryos and the parent. As the number of broods within the ovary increases the number of embryos in each brood decreases. Presumably the more

specialized types of superfetation have arisen from the simpler types because of two factors: (1) with reduction in the size of the yolk sac less time is required for its elaboration and so new groups of ova come to maturity and are ready for fertilization earlier; (2) the evolution of the follicular pseudoplacenta makes possible a longer retention of the embryos in the ovary. The retention of older embryos increases the number of broods within the ovary at any one time.

GOODEIDAE.—In this family embryos are evacuated from the ovarian follicles into the ovarian cavity during the early segmentation stages. Fertilization of as many as 175 ova occurs at the same time in some species (*Girardinichthys innominatus* and *Chapalichthys encaustus*). During early gestation the epithelium of the ovarian cavity becomes glandular and the ovarian stroma swells and becomes spongy. In late gestation the ovarian stroma shrinks and becomes very vascular while the epithelium of the ovarian cavity desquamates. These changes seem to have no effect upon the ovigerous tissue in which ovocytes proceed to differentiate and mature, with the result that new waves of ova appear while gestation is in progress. Many of the ovocytes degenerate. Due to the fact that the female is receptive to the male during gestation, sperm are present continually in the ovarian cavity and some of the newly matured ova are fertilized. The new embryos are evacuated into the ovarian cavity during the early segmentation stages and develop for a time along with the older embryos. It is not known whether this superfetation occurs in all of the twenty-five species of goodeid fishes but it has been observed occasionally in the following species: *Xenoöphorus erro, X. exsul, Chapalichthys encaustus, Zoogoneticus quitzeoensis, Skiffia variegata, Neotoca bilineata, Girardinichthys innominatus* and *Characodon lateralis*. It is apparent that the embryos of the second brood are not viable for any considerable length of time. Wherever observed, the living embryos of the second brood have been in early stages of development. No embryos in late stages have been found but numerous embryos in intermediate stages have been observed in a state of partial resorption. A simple superfetation occurs here because first, the ovigerous tissue pursues an independent development while a brood is still present in the ovary and so produces mature ova, and second, because viable sperm are present in the ovary and are able to fertilize the new mature ova within the follicles. The process is not effective in bringing the second brood through to the conclusion of the period of gestation, however, and the second brood is lost by death and absorption.

JENYNSIIDAE.—A single species, *Jenynsia lineata,* has been studied. Here, as in the family Goodeidae, the embryos are evacuated from the ovarian follicles into the ovarian cavity in early segmentation stages and new waves of ovocytes differentiate and mature in the ovigerous tissue while gestation is in progress. The newly matured ova generally become atretic but occasionally some of the ova are fertilized and the second brood of embryos lives for a short time within the ovarian cavity along with the first brood. The embryos of the second brood soon die and are absorbed completely or their remains are taken into the alimentary canals of the older embryos.

DISCUSSION.—The combination of factors which result in superfetation have been enumerated above. The independent development of ovocytes

within the ovary of the gravid female is not unique in these fishes. A similar situation exists in other viviparous vertebrates and ovulation occurs in some at the close of gestation. However, the maturation of ovocytes in a gravid ovary is confined to limited groups of viviparous teleost fishes. The fertilization of ova within the ovarian follicles in advance of the process of ovulation seldom occurs normally outside of the groups of viviparous fishes. An interesting exception is described by Strauss in the insectivor, *Ericulus*, in which the sperm penetrate the walls of the atypical ovarian follicles and fertilize the ovum, after which the fertilized ovum is slowly expelled from the ovary. The retention and storage of sperm in a viable condition within the female is common in reptiles as well as in viviparous teleosts, but a long interval between periods of maturation of ova prevents fertilization of new ova.

The most important factor favoring superfetation in viviparous cyprinodont fishes seems to be the short, often-repeated, reproductive cycle. Effective superfetation occurs in some members of a single family (Poeciliidae). Here each embryo is walled off from the rest of the ovary within a modified follicle and each embryo with its surrounding follicle becomes a separate physiological unit. In the Goodeidae and Jenynsiidae, where all embryos are expelled into the ovarian cavity, no such isolation exists and the entire brood, together with the ovary, becomes the physiological unit. A new brood of embryos has relatively little chance of survival. The ovary as a whole undergoes a series of differentiations which parallel the developmental stages of the embryos of the brood already present and the new brood comes into the ovarian cavity at a time in which the ovary is modified primarily in a direction favorable for the older embryos. Conditions for the embryos of the new brood are rendered still less favorable by the fact that they are retained within the same chamber as the older brood and must compete in this unfavorable environment.

Literature Cited

Turner, C. L.
1937 Reproductive cycles and superfetation in poeciliid fishes. *Biol. Bull.*, 72: 145–164.

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The Subspecies of *Notropis zonatus*, a Cyprinid Fish of the Ozark Upland

By Carl L. Hubbs and George A. Moore

THE striped shiner, *Notropis zonatus* (Agassiz), is one of the most characteristic fishes of the Ozark Upland (Interior Highlands), where it abounds in clear, mountain creeks. It is more common in moderately swift pools than in quiet waters or swift riffles.

This species is one of the most beautiful of American cyprinids. In life it shines like burnished silver, and the high males are flame-red on the lower sides of the body and head, reddish even on the back, and deep orange red on the fins, except for their gray borders. The lips, preopercular bar and pectoral axil are bright blood-red. In low males the red on the fins may be largely confined to submarginal bands. The dorsal fin is the most deeply colored, and may be green below the red; on the other fins the red may be much more reduced in area or intensity. In color and some other respects *Notropis zonatus* bears some resemblance to *N. coccogenis* of the Tennessee Upland, a circumstance reflected in the classification of some authors. The two possibly form one of the pairs of geminate forms inhabiting the two main Uplands of south central United States.

Preserved specimens on first examination seem much like *Notropis cornutus chrysocephalus* (with which *N. zonatus* is often taken). The general form is rather similar. In each the large dorsal fin is submedian, the anal rays are usually 9, the peritoneum is blackish, and the full complement of teeth is 2, 4—4, 2.

N. zonatus differs from *N. cornutus chrysocephalus* in the broader and blacker mid-dorsal stripe, the more distinct lateral band, and the better developed secondary stripe above the main band. This secondary stripe is more sharply separated from the main band and from the color of the back, not appearing as a darkened lower edging of the dorsal color. As several authors have mentioned, these distinctions in coloration are less obvious in the young than in adults, but another difference is evident in the juveniles: in young *zonatus* there is developed between the nostrils a pair of characteristic and usually conspicuous blackish crescents.

Compared further with *N. cornutus, N. zonatus* has less elevated scales with fewer radii, as stated by Cockerell and Callaway (1909: 190, 194-195). Typically it has a slenderer and more terete form, a sharper snout and a larger eye than *N. cornutus chrysocephalus*. These distinctions in form are commonly very striking; much more so at some localities than others. It is in just these characters that *Notropis zonatus* exhibits a remarkable variation. In some streams *zonatus* is a slender, subterete fish with a sharply pointed muzzle and a very large eye. In other waters it is deeper and more slab-sided, and has a much deeper head with blunter muzzle and smaller eye. The changes with age are in that direction, but there is much local, and individual, as well as age variation in these characters. Commonly, though not invariably, these features vary together so that on superficial study it would appear that two species are represented. There are many intermediate populations, however, and almost the whole range of variation may be observed at some localities. We have found it quite impossible to use these variations in form and proportion in any systematic separation. Irrespective of subspecies the depth varies from 3.6 to 5.0 as stepped into the standard length and the eye varies from 3.0 to 4.2 as measured into the head.

Overriding these variations in form is a differentiation in one feature, of coloration, that shows such remarkable geographic consistency that we do not hesitate to divide *Notropis zonatus* into two subspecies. In all the headwater streams of Missouri that drain through the Osage, Niangua and Gasconade

rivers northward into the Missouri River, in the Meramec River which is a direct tributary of the Mississippi in eastern Missouri, in the St. Francis River system of southeastern Missouri, and in the Black River system nearby in Missouri and Arkansas, that is, in the northeastern part of the Ozark Upland, all adults from all localities have a broad blackish scapular bar, becoming jet black in breeding males (in the young this mark is less well developed, but can usually be distinguished, at least under a microscope). In the spreading drainage basins of the White River system in Arkansas and Missouri and of the Neosho River system of Oklahoma, Arkansas and Missouri, and in other tributaries of the Arkansas River near the Arkansas–Oklahoma border, the adults show at most only a trace of the scapular bar and the mark is not discernible in the young. The difference, though small, is a very real one. Much of the material was properly sorted with the locality label concealed. Except for lots of only one or a few young fish, we have felt no hesitation in making the subspecific identification.

A name is available for each subspecies. The northeastern form, which may be called the Missouri striped shiner, is the typical subspecies, *Notropis zonatus zonatus* (Agassiz), as shown by an examination of cotypes as well as topotypes. For the form lacking the scapular bar we resurrect the name *pilsbryi* since *Notropis pilsbryi* was described from a region where this form abounds and since the original figure shows no scapular bar. The subspecies *Notropis zonatus pilsbryi* may be called the Arkansas striped shiner. Complete references are given below in the synonymies. The types of both forms have been studied by the senior author.

The black and perhaps the red colors average more intense in *N. z. zonatus* than in *N. z. pilsbryi,* but the blackish crescents developed between the nostrils of the young are generally the more conspicuous in *N. z. pilsbryi.*

The remarkable sharpness of the geographic break between the ranges of *N. z. zonatus* and *N. z. pilsbryi* is shown on the distributional map (Fig. 1). In southwestern Missouri *N. z. zonatus* ascends the southernmost tributaries of the Osage and Gasconade rivers almost to their extreme sources, to be separated by only a few miles from the headwater populations of *N. z. pilsbryi* in the Neosho and White river systems. By making a seine haul in almost any stream of the region, an ichthyologist could determine what drainage he is in. Along this stream divide no intergradation was observed, and probably none takes place. Near the junction of the Black and the White river systems in Arkansas the two forms would be expected to come in contact, except for the circumstance that the lowland habitat there largely if not wholly excludes the species. No intergradation has been indicated anywhere, but will probably be discovered, possibly in the system of the Little Red River, which enters the White River below the junction with Black River. From Little Red River we have seen only two young specimens, doubtfully referred to *N. z. pilsbryi.* One from near the headwaters was collected by John D. Black. The other specimen, in the National Museum, is labeled merely "Mid Fk Lit. R" in Meek's handwriting. It may be of pertinence that Meek (1891: 136, and 1894*b*: 82 and 92) did not record the species from this stream.

For each subspecies the map shows a very compact range, with the exception of two record stations far west of the usual boundaries of forms character-

istic of the Ozark Upland, and three from the Red River system. The specimens representing the only Kansas record came from a creek below rather large Jack Springs (according to the collector, Prof. John Breukelman). Another isolated western record, from the Arkansas River near Turkey Island in Panner County, Oklahoma, was taken by the junior author where large springs emerge in the bed of the main river. These two records, therefore, are not so unusual ecologically as they are geographically. Of the three records from the Red River system, one is from the shoals of Mountain Fork River near Mountain Fork, 5.6 miles slightly west of south of Smithville, McCurtain County, Oklahoma; another, based on a single young specimen, is from a clear stream (Clear Boggy Creek, 6 miles east of Wapanucka, Atoka County, Oklahoma); and the third, based on a large series, is for a muddy stream (Little Boggy Creek, 4 miles east of Stringtown, Atoka County, Oklahoma). These three records are so isolated as to suggest the possibility of an accidental transfer, either of data or of the living fish.

Except for a few isolated records discussed above, it is remarkable how closely the records for *N. z. pilsbryi* are confined to the White River system and to the tributaries of the Arkansas River north of the Arkansas proper and east of the Grand River. The latter stream is approximately on the line separating the Ozarks from the Plains, but in the mountains south of the Arkansas River there are multitudes of streams seemingly suited to this species yet not inhabited by it. Similarly the northern tributaries of the Arkansas River east of Clear Creek in western Arkansas, have failed to furnish a single specimen of *zonatus*, though many of these clear streams have been seined by John D. Black. In line with the evidence from other fishes, and in agreement with the sharp habitat preferences of *N. zonatus* for upland waters, Mr. Black is postulating that this species owes its distributional pattern to stream capture between the headwater tributaries of the Neosho and the White.

On the map we have plotted nearly all of the known records for both subspecies, as we have checked the literature carefully and have examined all material in the University of Michigan Museum of Zoology, the United States National Museum and the Museum of Comparative Zoology. Almost all literature records are substantiated by the original specimens or by new material from the same region. We are grateful to the officials of these museums, and to Mr. John D. Black who is making a fish survey of Arkansas, for the privilege of portraying adequately the geographical distribution of these shiners. All actual records are mapped, except the type locality ("Osage River") of *N. zonatus*. The types, No. 1914, Museum of Comparative Zoology, are labelled only "Osage R., Mo.," but specimens of *Notropis deliciosus missuriensis*, also collected by Geo. Stolley and bearing the Cat. No. 1919 in the same museum, are given as from "Marais, Osage R., Mo." Another specimen in the Harvard collection, taken by George Stolley, is labeled "Texas," presumably in error.

The few records for *Notropis zonatus* (and *N. pilsbryi*) from beyond the limits of the Ozark Upland prove on re-examination of the material to have been based on other species. Thus the five specimens from the Nolichucky River near Greenville, Tennessee, recorded as *N. zonatus* by Evermann and Hildebrand (1916: 444) and Evermann (1918: 343, 366), are found to

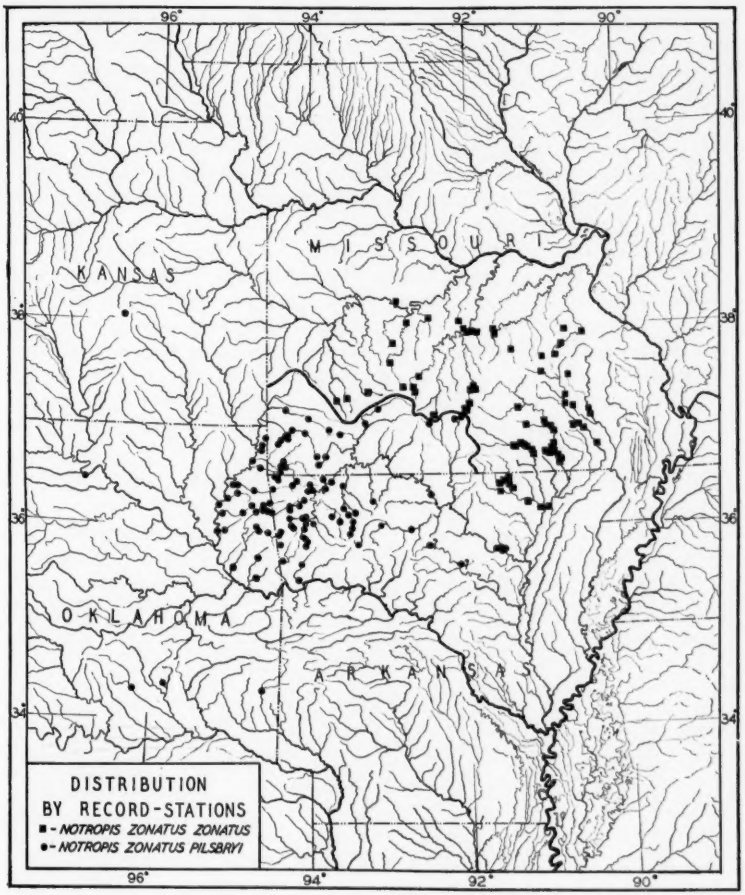

Fig. 1. Map showing by record stations the distribution of *Notropis zonatus zonatus* and *Notropis zonatus pilsbryi*.

Since almost all recorded material has been examined, no distinction is made between records based on specimens and on literature. The ranges of the two forms in Missouri are separated by a heavy black line following the main stream divide.

represent *Notropis ariommus telescopus*. Of these specimens two have 9 and three have 10 anal rays. This record was doubtless the basis for the recent inclusion of Tennessee in the range of the *N. zonatus* (by Pratt, 1935: 77).

Cockerell (1908: 170) reported "*Notropis zonatus* (Agassiz), var." [not "*Notropis notatus* (Agassiz), var.," as stated by some subsequent authors] from Boulder, Colorado, on the basis of a probable identification by Evermann. Soon thereafter the same specimens were described as *Notropis universitatis* sp. nov. by Evermann and Cockerell (1909: 187), as also noted by Cockerell and Callaway (1909: 195). Ellis (1914: 53) recognized *N. universitatis* as a distinct species closely related to *N. zonatus;* as did Schrenkeisen (1938: 127), who referred both species to *Hydrophlox*. Jordan, Evermann and Clark (1930: 124) accepted *N. universitatis* as valid, but separated it generically from *zonatus* and from *cornutus*. Hubbs (1926: 46) had already indicated that *N. universitatis* is a synonym of *Notropis cornutus frontalis*.

As stated by Hubbs and Brown (1929: 37), Forbes and Richardson (1909 and 1920: 149) misidentified, as *Notropis pilsbryi,* Illinois specimens of the hybrid, *Notropis cornutus* × *Notropis rubellus*. Somewhat similarly Jordan and Jenkins (in Jordan, 1889: 354) indicated *N. zonatus* as closely related to their new *Notropis macdonaldi,* which, as seen by a re-examination of the types, was based on the same hybrid combination (*cornutus* × *rubellus*).

The nomenclatorial and taxonomic history of the two forms is outlined in the following synonymies:

Notropis zonatus pilsbryi Fowler

Arkansas Striped Shiner
Plate 1, A and B

Notropis zonatus (identification correct to species only).—Jordan, 1885: 814 (characters and range; in part). Jordan and Gilbert, 1886: 2–4 (synonymy; description; Eureka Springs, Arkansas). Jordan, 1888: 59 (description; Ozark region; in part). Meek, 1891: 117, 126, 129 (records in Neosho and White river systems, Missouri); 1894a: 245–246 (all records, except those for streams near Mammoth Springs; range and habitat, in part); 1894b: 77, 87, 90, 92 (in part; records in White and Illinois river systems, Arkansas; young much like those of *N. cornutus;* in spring brooks). Evermann and Kendall, 1895: 470 (description; Indian Creek, Spring Branch and Shoal Creek, near Neosho, Missouri). Jordan and Evermann, 1896: 285 (description; mountain streams in Ozark region of Missouri and Arkansas; in part). Jordan, 1899: 59 (description; Ozark region; in part). Cockerell and Callaway, 1909: 190, 195 (scale structure; comparison and relationship; White River, Arkansas). Hubbs and Ortenburger, 1929: 81–82 (in part; records in Arkansas River system of Oklahoma, and from Sarcoxie, Missouri; *pilsbryi* indicated as a synonym of *zonatus;* color; nuptial tubercles). Hubbs and Brown, 1929: 37 *(pilsbryi* a synonym of *zonatus; N. pilsbryi* Forbes and Richardson is *N. cornutus* × *N. rubellus).*

Hydrophlox zonatus.—Jordan, 1929: 83 (description; Ozark region; in part). Pratt, 1935: 77 (characters and range; in part). Schrenkeisen, 1938: 127 (range; in part).

Coccotis zonatus.—Jordan, Evermann and Clark, 1930: 128 (range; in part).

Notropis pilsbryi.—Fowler, 1904: 245–246, 1 fig. (original description; compared with *N. luciodus;* Rogers, White river basin, Arkansas). Jordan, Evermann and Clark, 1930: 124 (reference to original description). Schrenkeisen, 1938: 123 (black lateral band; Arkansas).

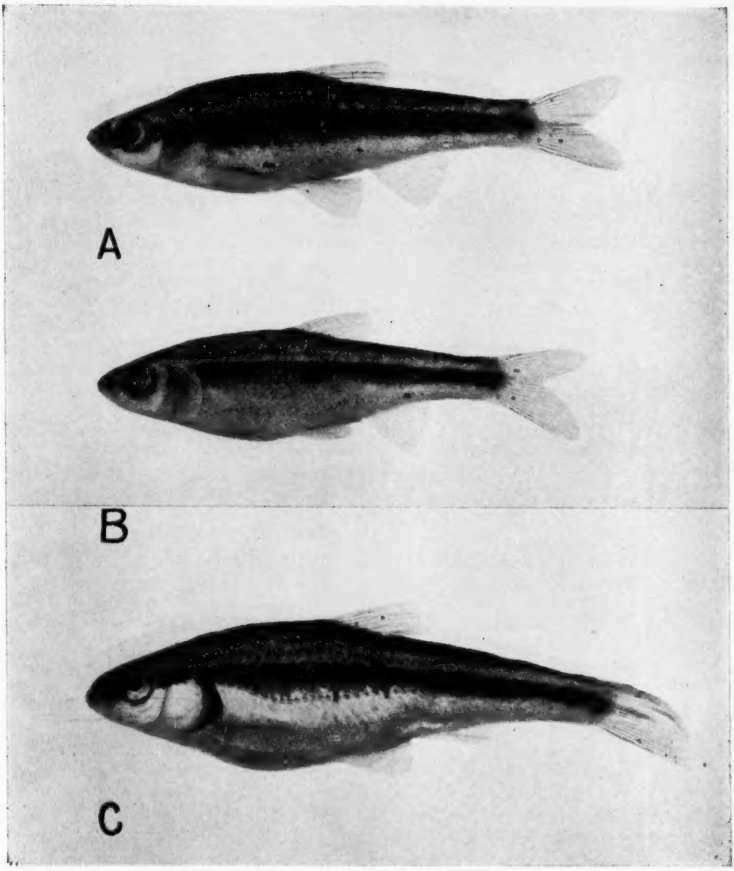

Plate 1, A. *Notropis zonatus pilsbryi:* a breeding male 73 mm. in standard length, from Shoal Creek, Barry County, Missouri (U. M. M. Z. 116414).

B. *Notropis zontatus pilsbryi:* a mature female 65 mm. long, from the same series.

C. *Notropis zonatus zonatus:* a postnuptial male 81 mm. long, from a tributary of Niangua River, Camden County, Missouri (U. M. M. Z. 102742).

Notropis zonatus zonatus (Agassiz)
Missouri Striped Shiner
Plate 1, C

Alburnus zonatus.—Agassiz, in Putnam, 1863: 9 (original description; Osage River).

Leuciscus zonatus.—Günther, 1868: 253–254 (description; Osage River).

Minnilus zonatus.—Jordan and Copeland, 1876: 154 (Osage River).

Cliola zonata.—Jordan and Gilbert, 1883: 183 (reference to Agassiz only; description based on *Notropis dorsalis piptolepis*).

Notropis zonatus.—Jordan, 1885: 814 (characters and range; in part). Call, 1887: 76 (records, Meramec, Gasconade and Black river systems, Missouri). Jordan, 1888: 59 (description; Ozark region; in part). Meek, 1891: 117, 118, 121, 125, 133, 140 (description; records in Meramec, Gasconade, Niangua and Osage river systems, Missouri; and in Black River system, Arkansas and Missouri); 1894a: 245–246, and 1894b: 77, 91–92 (records for streams near Black Rock and near Mammoth Springs, Arkansas; range and habitat, in part). Evermann and Cox, 1896; 355, 368, 372–374, 406, 427 (literature records for Missouri River system, Missouri). Jordan and Evermann, 1896: 285, and Jordan, 1899: 59 (description and range, in part). Hubbs and Ortenburger, 1929: 81 (in part; only two records, near Potosi and Shepard, Missouri).

Hydrophlox zonatus.—Jordan, 1929: 83 (description; Ozark region; in part). Pratt, 1935: 77 (characters and range, in part). Schrenkeisen, 1938: 127 (range; in part).

Coccotis zonatus.—Jordan, Evermann and Clark, 1930: 128 (range; in part).

Literature Cited

Call, R. Ellsworth
1887 Memoranda on a collection of fishes from the Ozark region of Missouri. *Proc. Davenport Acad. Sci.*, 5: 73–80.

Cockerell, T. D. A.
1908 The fishes of the Rocky Mountain region. *Univ. Colo. St.*, 5: 159–178, figs. 1–9.

Cockerell, Theodore D. A., and Otis Callaway
1909 Observations on the fishes of the genus Notropis. *Proc. Biol. Soc. Wash.*, 22: 189–196.

Ellis, Max M.
1914 Fishes of Colorado. *Univ. Colo. St.*, 11: 1–136, pls. 1–12.

Evermann, Barton Warren
1918 The fishes of Kentucky and Tennessee: a distributional catalogue of the known species. *Bull. U. S. Bur. Fish.*, 35, 1915–16: 295–368.

Evermann, Barton Warren, and Theodore D. A. Cockerell
1909 Descriptions of three new species of cyprinoid fishes. *Proc. Biol. Soc. Wash.*, 22: 185–188.

Evermann, Barton Warren, and Ulysses O. Cox
1896 A report upon the fishes of the Missouri River basin. *Rept. U. S. Comm. Fish and Fish.*, 1894: 325–429.

Evermann, Barton Warren, and Samuel F. Hildebrand
1916 Notes on the fishes of East Tennessee. *Bull. U. S. Bur. Fish.*, 34, 1914: 431–451, figs. 1–13.

Evermann, Barton W., and William C. Kendall
1895 A list of the species of fishes known from the vicinity of Neosho, Missouri. *Ibid.*, 14 (1894): 469–472.

Forbes, Stephen Alfred, and Robert Earl Richardson
1909 The fishes of Illinois. *Nat. Hist. Surv. Ill.*, 3: i-cxxxi, 1–357, many figs. and pls.
1920 *Ibid.* (2nd ed.)

Fowler, Henry W.
1904 Notes on fishes from Arkansas, Indian Territory and Texas. *Proc. Acad. Nat. Sci. Phila.*, 1904: 242–249, 1 fig.

Hubbs, Carl L.
1926 A check-list of the fishes of the Great Lakes and tributary waters, with

nomenclatorial notes and analytical keys. *Mus. Zool. Univ. Mich. Misc. Publ.*, 15: 1–77, pls. 1–4.

HUBBS, CARL L., and DUGALD E. S. BROWN
1929 Materials for a distributional study of Ontario fishes. *Trans. Roy. Can. Inst.*, 17: 1–56.

HUBBS, CARL L., and A. I. ORTENBURGER
1929 Fishes collected in Oklahoma and Arkansas in 1927. *Publ. Univ. Okla. Biol. Surv.*, 1: 45–112, pls. 6–13.

JORDAN, DAVID STARR
1885 A catalogue of the fishes known to inhabit the waters of North America, north of the Tropic of Cancer, with notes on the species discovered in 1883 and 1884. *Rept. U. S. Fish Comm.*, 13: 287–973.
1888 A manual of the vertebrate animals of the northern United States including the district north and east of the Ozark mountains, south of the Laurentian hills, north of the southern boundary of Virginia, and east of the Missouri River inclusive of marine species. (5th ed.). Chicago: A. C. McClurg and Co.: 1–375.
1889 Descriptions of fourteen species of fresh-water fishes collected by the U. S. Fish Commission in the summer of 1888. *Proc. U. S. Nat. Mus.*, 11, 1888: 351–362, pls. 43–45.
1899 A manual of the vertebrate animals of the northern United States . . . (8th ed.). Chicago: A. C. McClurg and Co.: 1–397.
1929 Manual of the vertebrate animals of the northeastern United States inclusive of marine species. (13th ed.). Yonkers, N. Y.: World Book Co.: i-xxxi, 1–446.

JORDAN, DAVID S., and HERBERT E. COPELAND
1876 Check list of the fishes of the fresh waters of North America. *Bull. Buffalo Soc. Nat. Sci.*, 3: 133–164.

JORDAN, DAVID STARR, and BARTON WARREN EVERMANN
1896 The fishes of North and Middle America. *Bull. U. S. Nat. Mus.*, 47 (pt. 1): i-lx, 1–1240.

JORDAN, DAVID STARR, BARTON WARREN EVERMANN and HOWARD WALTON CLARK
1930 Check list of the fishes and fish-like vertebrates of North and Middle America, north of the northern boundary of Venezuela and Colombia. *Rept. U. S. Fish Comm.*, 1928 (pt. 2): 1–670.

JORDAN, DAVID S., and CHARLES H. GILBERT
1883 Synopsis of the fishes of North America. *Bull. U. S. Nat. Mus.*, 16: 514–521.
1886 List of fishes collected in Arkansas, Indian Territory, and Texas, in September, 1884, with notes and descriptions. *Proc. U. S. Nat. Mus.*, 9: 1–25.

MEEK, SETH EUGENE
1891 Report of explorations made in Missouri and Arkansas during 1889, with an account of the fishes observed in each of the river basins examined. *Bull. U. S. Fish Comm.*, 9, 1889: 113–141.
1894*a* A catalogue of the fishes of Arkansas. *Ann. Rept. Geol. Surv. Ark.*, 2, 1891: 215–276, pls. 1–12.
1894*b* Report of investigations respecting the fishes of Arkansas, conducted during 1891, 1892, and 1893, with a synopsis of previous explorations in the same state. *Bull. U. S. Fish. Comm.*, 14: 67–94.

PRATT, HENRY SHERRING
1935 A manual of land and fresh water animals of the United States (exclusive of birds). (2nd ed.). Philadelphia: P. Blakiston's Son & Co.: i-xvii, 1–416, figs. 1–184, 1 map.

PUTNAM, F. W.
1863 List of the fishes sent by the museum to different institutions, in exchange for other specimens, with annotations. *Bull. Mus. Comp. Zool.*, 1: 1–16.

SCHRENKEISEN, RAY (edited by J. T. Nichols and F. R. LaMonte)
1938 Field book of fresh-water fishes of North America north of Mexico. New York: G. P. Putnam's Sons: 1–312, 1 pl., 97 figs.

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Reproductive Behavior in the Eastern Johnny Darter, *Boleosoma nigrum olmstedi* (Storer)

By James W. Atz

THESE notes on the behavior of a common fresh-water fish are the result of forty-six hours of observation of the actions of a single male in one of the exhibition tanks at the New York Aquarium. The only account of the spawning actions of *Boleosoma nigrum olmstedi* (Storer) is apparently Seal's (1892) brief one.

Our observations extended from May 24, the date spawning was first observed, to June 15, 1939. The subject was a male, 5 cm. in standard length, which had been taken from Jones Creek, a tributary of the Swimming River in Monmouth County, New Jersey, together with a number of other specimens on April 10 by Mr. William C. Bennett of the Aquarium staff. The male exhibited a darker body pattern, consisting principally of about ten vertical bars on each side, dusky dorsals, caudal, ventrals and anal fins (but clear pectorals) and metallic coloring on the head, all of which have previously been described (e.g. Seal, 1892). The females exhibited a prominent genital papilla at the time of spawning, the male none.

The Nest

All accounts known to the author of the nest of either subspecies of this darter, as found in nature, agree that the eggs are deposited on the under side of some submerged object, usually a stone.

Boleosoma nigrum nigrum: The eggs of this species were only found on the under side of small objects lying on the bottom in shallow water. The many nests found were under flat stones about the size of a person's hand, or smaller, a single exception was one that was placed beneath the valve of a mussel shell which lay concave side down. (Hankinson, 1908.)

Eggs have been found on splinters, a piece of tile, and a mussel shell (l.c.). The stones used were all small, none with any diameter greater than ten inches. Beneath all these objects there has been space sufficient to permit a free movement of the attending fish and this has been opened to the exterior, permitting the fish to move in and out. (Hankinson, 1919.)

Boleosoma nigrum olmstedi: In June, 1906, Foreman Scriba discovered some small eggs attached to the under surface of stones in Frederick Creek.[1] (Bean, 1907.)

Eggs of this species . . . were on the under side of a large piece of tin that lay on the bottom in two feet of water . . . Wright and Allen ('13, p. 6) give as the breeding place of the Johnny Darter (very probably including this species), gravelly shallows under stones or overlapping edges. (Adams and Hankinson, 1928.)

The location of the nest may be in "gravel-covered, marly shoals" (Hankinson, 1908), in "shallow parts of streams with water under a foot in depth and where the current was moderate and the bottom gravelly" (Hankinson, 1919), on "stony shallows" (Hankinson, 1932), or on "sandy bottom" (Raney and Lachner, 1939).

However, the fact that the eggs may sometimes be laid on the upper

[1] These eggs were subsequently hatched and the young fish identified.

surface of submerged objects cannot be overlooked. Seal (1892) found, "The eggs were deposited on the under surfaces of stones, or on the backs of them, where one leaned against the ends or back of the tank, or against another stone . . ." This was in an aquarium. James L. Kezer of the New Jersey Teachers' College observed a male *B. nigrum olmstedi* which selected the top of a flat rock in the open as the site of his nest in preference to the many stones piled up in the corners of an aquarium. There were a number of places where a "typical" nest might have been located, Mr. Kezer assures me.

The under side of a fresh-water mussel shell, *Unio*, was the resting place of the eggs under our surveillance. The valve lay concave side upward, thus being the reverse of the one Hankinson (1908) saw.

Hankinson (1908) states, "No evidence of any excavating or other nest building process by the species was obtained;" nor has anyone, to the author's knowledge, since made such observations. However, it may well be that this darter does excavate or at least enlarge holes under submerged objects. Several times the male under observation was seen to enlarge the space under a mussel shell by means of rapid, sweeping strokes of the body and tail, pushing the coarse sand, with which the bottom of the tank was covered, to either side and leaving the fish in a slight depression. Other times he plowed forward, his head and pectoral fins pushing sand before him.

Observations in general have indicated that "there is usually but one male to a stone," as Raney and Lachner (1939) stated. These authors found, however, that "as many as three males of *Boleosoma nigrum olmstedi* at times have holdings under one large stone" where "satisfactory breeding sites were unusually scarce. As far as is known," they continue, "there is but one male to a stone and set of eggs for the western johnny darter, *Boleosoma nigrum nigrum* . . ."

It might here be noted that Hankinson (1908) suggests that there may be a spawning migration of *B. n. nigrum* into small creeks, the fish remaining here only during the breeding season.

Courtship and Spawning Behavior

Already a number of eggs had been laid when the first observation was made. As previously stated, they were adhering to the under side of a mussel valve which lay concave side upward. Underneath them was the male, guarding them and frequently turning upside down and passing over them. (See section on care of eggs.)

It was determined that more than one female may spawn in a single male's nest, as Hankinson (1932) has indicated, and that spawning, for the male at least, may continue intermittently for some time. The spawning act was observed in one pair 50 times from 9:27 to 11:27 A.M. on May 24. Three more hours of watching that afternoon witnessed but two additional acts. Only two more were observed up to May 31, although over fifteen hours of observation (see Fig. 1) were made during these six days, and several performances, seemingly courtship, were recorded. On the last day of May, 46 acts were seen from 8:40 to 9:40 A.M., but this time with a different female from the one spawning the week previously. From his attitude toward females, it was supposed that the male might have spawned, had a mature mate been

present, as late as June 9, although no actual spawning was observed in the twenty-three hours of observation in June.

The spawning act proved to be quite variable. It was, nevertheless, invariably performed upside down. Sometimes spawning occurred cichlid-fashion, the male going over the place where the female had just quivered. (It was impossible, save once or twice, to see the actual deposition of the egg, so the assumption was made that in many of the instances where the female was seen to quiver violently, laying took place. It was definitely noticed that the number of eggs under the valve increased during the time of observation.) More often the partners assumed a side by side position, head to tail, or, perhaps more frequently, head to head. There was no clasping of the female by the male, nor did he ever ride upon her back, as is done in some other species of darter, although rarely the fish became oriented crosswise, the male superior, that is, nearer the floor of the tank. Sometimes the male lay slightly over on his side nearest the female so that his anal fin rested against her side. On May 31 the position most often assumed was side to side with the male, his belly not quite as close to the shell as that of the female, leaning toward her with his peduncle crossed over hers. This was the closest approach to a clasping position taken, for the male seemed to press his partner's body upward toward the under surface of the valve.

Seal (1892) has stated, "The spawning was effected by passing up and down over the surface chosen until all the eggs were extruded and adhering to the stone." This would seem to be in substantial agreement with the present observations. Forbes and Richardson (1920), however, under the heading of the other subspecies, *B. n. nigrum,* describe how the male "rode on the back of the female . . . as the pair moved about on the bottom." Hankinson (1908, 1919, 1932) definitely states that eggs of this fish, together with guarding males, were found only on the under side of submerged objects. It may very well be that Forbes and Richardson had a different species under observation. The performances of their fish seem to be very like those described for *Hadropterus* (Petravicz, 1938).

The general impression received was that the spawning act of *B. nigrum olmstedi* is not a particularly well coordinated affair and that there is a good deal of lost motion in the process. (See section on care of eggs for additional comment on fertilization.)

Spawning activities were sometimes interrupted by another fish, darter or stickleback, approaching the nest. The male would then leave off spawning

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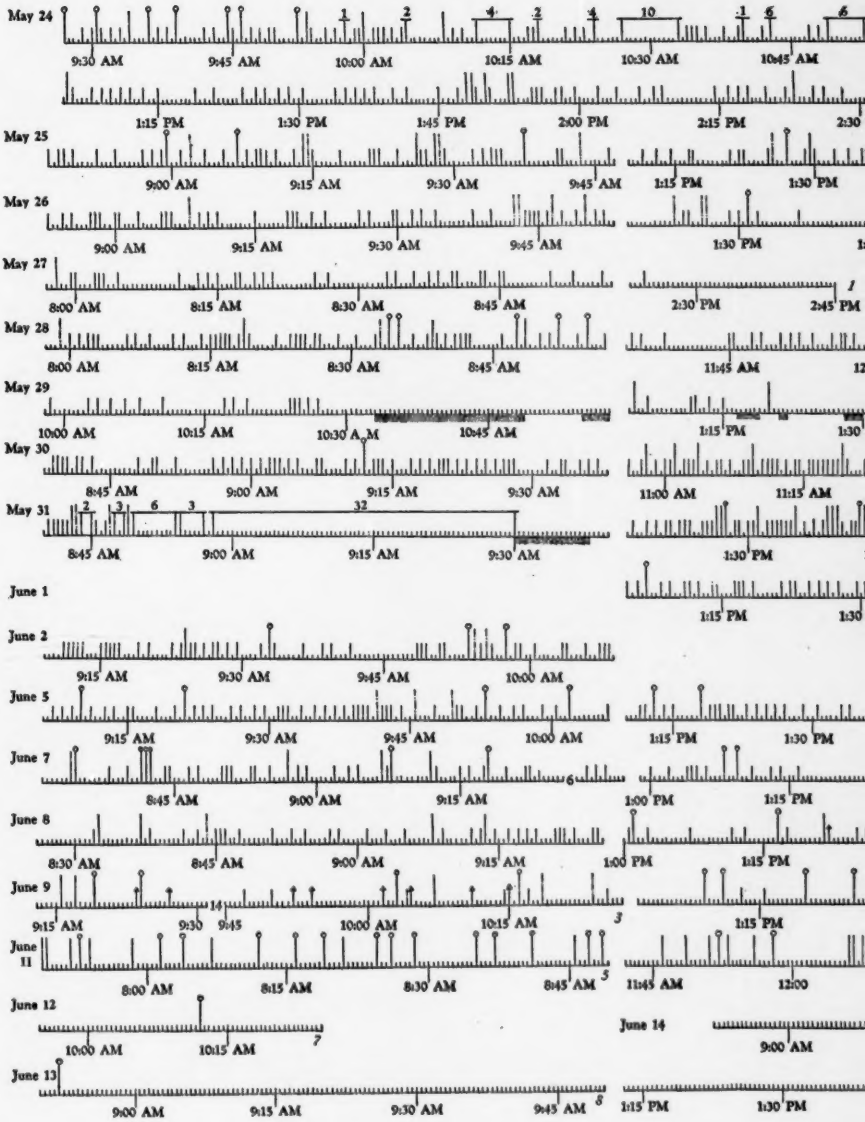
Fig. 1. Activities of male *Boleosoma nigrum olmstedi.*

All acts read to nearest half-minute; shortest vertical lines each indicate one half-minute. Longest solid vertical lines indicate chasing of a darter, sex unknown; lines with circles affixed, chasing of a female darter; shorter solid lines, going over eggs upside down; arrow-shaped lines, going over shell of new nest upside down; broken lines, courting of a female; T-shaped lines, spawning. Numbers over spawning symbols indicate number of consecutive acts. Heavy shading under base-line on May 29 means feeding, on May 31, continuous upside down going over of eggs. Numbers interposed in base-line mean minutes without observation.

1 Male away from nest most of this period.
2 Daphnia fed, after which male eats, chases other darters, but returns frequently to nest.
3 Male spends more time in new nest than old, but neither is well cared for.
4 Male in new nest most of this period.
5 Nests visited only occasionally, this period and next.
6 Male in nest, mostly new one, the greater part of the period.
7 Male in original nest most of period.
8 Male very inactive all this period.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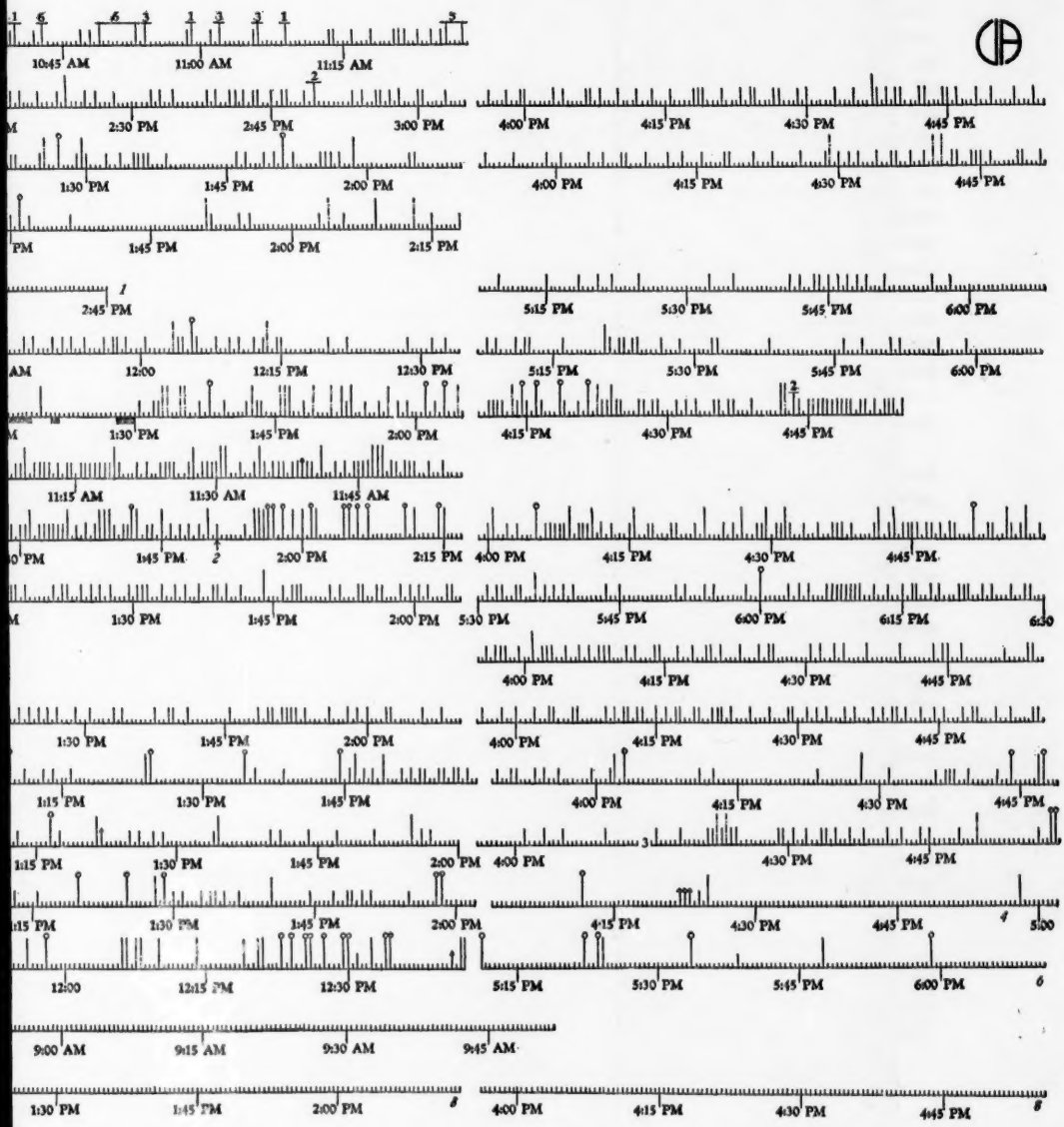
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to chase these intruders; the female either waited for him to return or also left the nest. All the darters in the tank under observation, save the one male were females or immature males. Seal (1892) describes how in captivity other males may try to spawn with a mating pair:

> The fish undoubtedly pair, for, although all the males would be in a state of great excitement and would endeavor to join in the operation, they were invariably driven away by the successful male, who would dart at them furiously with open mouth and fins quivering with excitement, the colors glowing with increased brilliancy and intensity.

With both male and female in proximity to the nest, spawning may be instigated by either one, by turning upside down. This is usually the signal for the other to follow, and the actual spawning commences. The male of these observations instigated more spawnings than did the female. There was a very simple courtship, if it may be called that. It consisted of the male's swimming out to a female and then returning to the nest, often to turn upside down immediately and pass over the previously laid eggs. The female might follow the male back to the nest and then might spawn with him. Two or three times during all the observations the male was seen *gently* to bite the female while they were in the nest.

An interesting point came up in connection with these excursions of the male. This was the difficulty of distinguishing between sallies made for the purpose of attracting females back to the nest and those made to drive them away—the usual reaction of a guarding male toward another fish. Both, as far as could be determined, start in exactly the same way. The male, fins extended to their utmost, swims vigorously out to the strange fish. Now he may immediately return to his nest; he may wait for a while, facing the other fish, then return; he may wait, facing it, until the fish swims away and then return; he may attack it after waiting, or not until it starts to swim away may he pursue it; he may attack it immediately. Just where courtship ends and defense begins was undeterminable. This too subtle difference, if any, between fighting and love-making in fishes has been noted by at least one author before (Breder, 1934, 1936), and the writer has experienced similar difficulties in observations on the cichlid, *Geophagus*. Either there is really a merging of the two social attitudes, or the supposed differences in "mental state" give rise to identical outward responses. A third possibility, of course, is that there *are* differences between these responses, but too fine to be distinguished in ordinary careful observations.

During the first day or two the male was decidedly antagonistic toward all fish which approached his nest. Most spawnings were effected only after the female had gotten into the nest "by the back door," so to speak, without the male's noticing her. Once she was in the nest spawning would take place, although quite often the male would apparently drive the female away after the completion of one, two or three acts. Either fish, however, would instigate these acts. A definite change later took place. The females no longer had to "sneak" into the nest. They were still chased now and then, to be sure, but many times the male did not attack them, trying instead to lure them back to his nest. Sometimes he was successful; more often the female responded not at all or followed him back to the nest and then swam away.

Care of Eggs

After spawning, the activities of the male may be considered as of two sorts: guarding the nest and caring for the eggs. The former is well known; the latter, it would seem, has not been described. The female abandons the nest permanently after all desire to spawn has left her.

Hankinson (1908, 1932), in discussing *B. n. nigrum* and Seal (1892), Adams and Hankinson (1928) and Raney and Lachner (1939), in reference to *B. nigrum olmstedi,* agree that the male defends the nesting site. Whether or not this duty is performed until all of the eggs hatch is not definitely known, although Seal (1892) states, "The male guards the eggs incessantly and drives every fish from the vicinity during incubation, retaining the brilliant color until that duty is over." Apparently it has been tacitly assumed by others that the guarding ceased upon the hatching of the eggs. Our observations, unfortunately, were terminated before this could be determined.

Hankinson (1908) made the following interesting field observations:

> These nests were each guarded by a black-pigmented male, which was tireless in his attempts to drive away the numerous blunt-nosed and straw-colored minnows which were trying to get at the eggs, but his small size prevented the darter from injuring the intruders, and they gave him little attention. Doubtless the eggs were more protected by being covered than by the energy of their guardian.

In our fish the guarding impulse was not perfectly developed. Up to about June 9 he was fairly attentive to the egg site, but lapses were not rare. The seeking of food and the courting of females were two of the distractions keeping him away from his nest for as long as a quarter of an hour. Besides the other johnny darters in the tank, there were quite a number of four-spined sticklebacks, *Apeltes quadracus* (Mitchill). Because of his larger size and aggressiveness the male darter had no trouble at all keeping these fish away from his shell. The other darters, although some were larger than he, were also completely dominated, even on feeding grounds 18 inches or more away from the nest. Three days after observations began, it was noted that the sticklebacks had "learned" to avoid that part of the tank near the nest. Thus, despite the male's lapses of parental solicitude, no eggs were seen to be eaten by them until near the conclusion of the observations when the male was indisposed. (See section on termination of observations.)

There were two actions of the male which are interpreted as functioning in the aeriation and cleaning of the surface of the eggs. By directing himself so that his tail pointed toward the eggs or lay under them and then moving it back and forth, meanwhile holding his position with the aid of his pectorals, he seemed to stir up the water about the eggs. A single act of this kind did not exceed four seconds in length. This was done many times in almost exactly the same way, but not so often as the following action to be described.

This consisted of swimming over the eggs while upside down, the pectorals, ventrals and often the anal brushing over them. Since the pectoral fins were employed in locomotion over the eggs, they actually rubbed their surfaces. This act usually did not last more than twenty seconds, but might extend to over five minutes. Sometimes the male rested upside down between flurries

of activity. If near the vertex of the acute angle between the valve and the substratum, he rested on his back, if farther out, he used the erected spines of the first dorsal fin to hold him up. The female which spawned on May 31 was also seen to employ her dorsal spines in this fashion during rests between spawning acts.

It was thought that by counting the number of times the cleansing activity was indulged in, a quantitative estimate of the waxing and waning of parental solicitude would be obtained. It was discovered, however, that so many variables entered into the picture that an interpretation of the doubtfully statistically significant differences was impossible. Moreover, the observer was again confronted with a paradoxical lack of differentiation in behavior. As far as could be determined, the male's cleansing actions were identical with those of spawning and those of instigating the spawning act, for the actual shedding of milt could never be seen. Obviously, the male could not be fertilizing the eggs over a week after they had been laid, but did he continue to shed milt over them? This would *a priori* seem improbable, yet when he passed over the eggs immediately before or a short while after the spawning act might he not have been so doing? And when, upon returning from an unsuccessful attempt to induce a female to return to the nest, he immediately turned over to caress his eggs, was this action stimulated by the eggs, the female or both? Thus, it would appear the motivations of all three actions merge indistinguishably, although the same three possible explanations mentioned in the relation of courtship to fighting apply here. (See section on courtship and spawning behavior.) Nevertheless, the average number of times the act of cleansing was performed per half-hour was calculated. It was 13; 16 if the last four days, when the male was definitely indisposed, are not included.

Only once throughout the observational periods was the male seen to touch the eggs with his mouth. This was on June 1 when he appeared to pick off and eat a few on the periphery of the egg mass.

Adams and Hankinson (1928) have performed the only experiment concerning the territorial behavior of this fish. They found a male guarding eggs on the "under side of a large piece of tin . . . When the tin was removed, he remained about the spot where it had lain, and when driven away he would promptly return. The tin was placed in a dip-net and lowered to the bottom near the male fish which came at once under the net." This would seem to indicate that the male guards the place, not the eggs, where the nest is located.

Termination of Observations

On June 7 it was noted that the male had dug or enlarged a trench about another mussel valve lying next to the one to which the eggs were attached. On June 9 he had a similar hollow about two shells which were about 18 inches away from the original nest. He spent an increasingly greater part of succeeding days there. Previous to this, his care of the eggs had become quite lax, and on that day sticklebacks were seen stealing the eggs for the first time. Sometimes the male turned upside down and went over the bare under-

surface of the shells. Females entered this new nest a few times and the male turned over in their presence, but no spawning acts were witnessed.

Meanwhile it had appeared that the male was suffering from some disorder, and on June 11 white spots were seen on his body and fins. He became less and less active, lost his dark coloring, and on June 20 was found dead. An examination by Dr. Ross F. Nigrelli, the Aquarium's pathologist, indicated that *Ichthyophthirius multifillis* (Foquet) had probably been the cause of death. How much of the male's behavior had been conditioned by his indisposition in the last days of observation is problematical.

Because more and more eggs were being destroyed by sticklebacks, the shell upon which they rested was removed from the tank on June 14. The following day a number, but not all, of the darters had hatched out. The temperature in the tank had been about 65° F. The eggs, laid in a single layer over the shell, were approximately spherical with a diameter of about 1½ mm. The yolk was amber in color and the oil globule exceptionally dark amber. The exterior was smooth, with various foreign matter adhering to it.

To my mentor, Dr. Charles M. Breder, Jr., I wish to express my deep gratitude for the aid and inspiration that made the above effort possible.

Literature Cited

Adams, Charles C., and Thomas L. Hankinson
1928 The ecology and economics of Oneida Lake fish. *Roosevelt Wild Life Annals*, 1 (3–4). *Bull. N. Y. St. Coll. Forestry*, 1 (4a): 235–548.

Bean, Tarleton H.
1907 Report of the state fish culturist for the year 1906. *Ann. Rept. Forest. Fish and Game Comm. N. Y. for 1904–1905–1906.* (See page 187.)

Breder, Charles M., Jr.
1934 An experimental study of the reproductive habits and life history of the cichlid fish, *Aequidens latifrons* (Steindachner). *Zoologica* (New York), 18 (1): 1–42.
1936 The reproductive habits of the North American sunfishes (family Centrarchidae). *Zoologica* (New York), 21 (1): 1–48.

Forbes, Stephen A., and Robert E. Richardson
1920 The fishes of Illinois. *Nat. Hist. Survey of Illinois*, 3: I–CXXXVI, 1–357. Second edition.

Hankinson, Thomas L.
1908 A biological survey of Walnut Lake, Michigan. *St. Bd. Geol. Survey Michigan, Rept. 1907*: 157–288.
1919 Notes on life-histories of Illinois fish. *Trans. Illinois St. Acad. Sci.*, 12: 132–150.
1932 Observations on the breeding behavior and habitats of fishes in southern Michigan. *Pap. Michigan Acad. Sci., Arts and Lett.*, 15, 1931: 411–425.

Petravicz, Walter P.
1938 The breeding habits of the black-sided darter, *Hadropterus maculatus* Girard. Copeia (1): 40–44.

Raney, Edward C., and Ernest A. Lachner
1939 Observations on the life history of the spotted darter, *Poecilichthys maculatus* (Kirtland). Copeia (3): 157–165.

Seal, William P.
1892 Observations on the aquaria of the U. S. Fish Commission at Central Station, Washington, D.C. *Bull. U. S. Fish Comm.*, 10, 1890: 1–12.

New York Aquarium, Battery Park, New York City.

Mating Time and Sperm Viability in *Storeria*

By Harold Trapido

In studying reproduction in the snakes of the genus *Storeria* the writer was impressed with the paucity of information available, not only for this group but on the reproduction of snakes in general. At the suggestion of Dr. Hermann Rahn, who is independently working on similar problems, I have prepared a summary of my preliminary observations.

Ruthven (1912, 1915), working with *Thamnophis butleri,* found the "gestation period" to vary as much as forty days. He suggested that this variation in developmental time was an expression of variation in temperature. In *Storeria dekayi,* Noble (1937) gave the mating time as from April 12 to 22; his co-worker Clausen (1936) placed it during the last week of March or the first part of April. Clausen (1936) also determined the "gestation period" as varying between 105 and 113 days. He concluded that the gestation period was rather exact in this species and that the wide variation in time of parturition, according to various authors,[1] was due to differences in the breeding time.

It has been generally assumed that the spring mating behavior, so readily observable in various snakes, results in the transfer of the male germ cells to the genital tract of the female; that ovulation in the female snakes occurs at or about the time of mating; and that the spermatozoa promptly make their way up the oviduct and fertilize the eggs.

In snakes, however, the period from copulation to fertilization has never been established, nor has the length of life of the spermatozoa. Some have suspected that the story of reproduction might not be so simple as was supposed. Thus Gloyd (1934) considered the possibility of late seasonal mating and examined fall-caught female copperheads (*Agkistrodon m. mokasen*) for spermatozoa, but with negative results. Later observations led him to say "that the male germ cells may live within the body of the female eleven days and perhaps considerably longer."

A female *Storeria dekayi* which was received in early October, 1938, from Br. Alexander Blouin of Mont-Saint-Louis College, Montreal, was kept in captivity, alone, or for a time with several garter snakes, until the 6th of December, when it was dissected. Mature spermatozoa were found in abundance in the oviducts. The specimen was taken in the last part of August, and kept in a container with two green snakes (*Opheodrys vernalis*) and a red-bellied snake (*S. occipito-maculata*) until they were sent to the writer. In a letter, Br. Alexander said, "There has surely been no male Dekay's snake with the female you have, since the end of August." It is thus apparent that the male germ cells lived more than three months in the female genital tract.

During the fall of 1938 the writer dissected specimens of *Storeria occipito-maculata* and made smears of the fluid in the reproductive tracts of both males and females. The vas deferens of males, without exception, had mature

[1] Noble and Clausen, 1936; Clausen, 1936; Ditmars, 1907; Conant, 1938; Force, 1930; Conant and Bailey, 1936; Shields, 1929; Guthrie, 1926; Trapido, 1939.

spermatozoa, which were exceedingly active in a drop of normal saline solution on a microscopical slide. On October 20, a female, which had been taken on October 10, was dissected and its left oviduct removed and washed with a normal saline solution. This wash was found to be swarming with actively swimming spermatozoa. Several days later three other female snakes were dissected and air dried smears prepared from the fluid in their oviducts with the same results—each had an abundance of sperm present. One female, examined on October 24, had only scattered blood cells, epithelial cells, and bacteria in the fluid of the oviduct; there were no sperm. This year (1939) a pair of *Storeria occipito-maculata* taken by Mr. John Belkin at Varna, near Ithaca, New York, on September 6 were in coitus. Additional records of matings other than in the spring are those of Bishop (1927) for *Storeria occipito-maculata* on July 9, and Dymond and Fry (1932) for *Opheodrys vernalis* in August.

Of further interest is a specimen of *Storeria dekayi* mentioned by Noble and Clausen (1936) which was collected in November, 1933, and gave birth, in the laboratory, to five young on March 20, 1934. It becomes apparent that the gestation period of this species is much longer than Clausen (1936) supposed, or that this snake either consumated a successful fall mating or retained viable sperm in her oviducts for a fall fertilization.

Woodward (1933) has shown that spermatozoa may actively persist for five months in the female of the African night adder, *Causus rhombeatus*. Rahn (this issue of COPEIA) and the writer have shown a similar long life for sperm in the snakes of the genera *Thamnophis* and *Storeria*.

Records above indicate that snakes in temperate North America may mate any time in the summer and fall as well as the spring. Since the spermatozoa are so long-lived in the oviducts of the female, the time from spring mating to parturition cannot be taken as the gestation period, as has been done previously. The determination of the gestation period must come through the investigation of the length of life of the male germ cells in the female genital tract, and their effectiveness for fertilization after a long period of time. Much can be done toward a solution of this problem by the herpetologist who is fortunate enough to find a den early in the year, before spring mating, and examine the oviducts of the females for spermatozoa; or who has facilities for carrying fall captured females through hibernation, determining their pregnancy with certainty the following year.

LITERATURE CITED

BISHOP, S. C.
1927 The amphibians and reptiles of the Allegheny State Park. *N. Y. State Mus. Handbook* 3: 1–141.

CLAUSEN, H. J.
1936 Observations on the brown snake *Storeria dekayi* (Holbrook), with especial reference to the habits and birth of young. COPEIA, 1936: 98–102.

CONANT, ROGER
1938 The reptiles of Ohio. *Amer. Midland Nat.*, 20: 1–200.

CONANT, ROGER and R. M. BAILEY
1936 Some herpetological records from Monmouth and Ocean counties, New Jersey. *Occ. Pap. Mus. Zool., Univ. Mich.*, 328: 1–10.

DITMARS, R. L.
1907 The Reptile Book. N. Y., Doubleday, Page and Company: 1–472.

DYMOND, J. R. and F. E. J. FRY
1932 Notes on the breeding habits of the green snake (*Liopeltis vernalis*). COPEIA, 1932: 102.

FORCE, E. R.
1930 The amphibians and reptiles of Tulsa County, Oklahoma, and vicinity. COPEIA, 1930: 25–39.

GLOYD, H. K.
1934 Studies on the breeding habits and young of the copperhead, *Agkistrodon mokasen* Beauvois. *Pap. Mich. Acad. Sci., Arts, Letters*, 19: 587–604.

GUTHRIE, J. E.
1926 The snakes of Iowa. *Iowa State Col. Agric. Mech. Arts, Bull.*, 239: 146–192.

NOBLE, G. K.
1937 The sense organs involved in the courtship of *Storeria, Thamnophis* and other snakes. *Bull. Amer. Mus. Nat. Hist.*, 73: 673–725.

NOBLE, G. K. and H. J. CLAUSEN
1936 The aggregation behavior of *Storeria dekayi* and other snakes. *Ecol. Monog.*, 6: 269–316.

RAHN, HERMAN
1940 Sperm viability in the uterus of the garter snake, *Thamnophis*. COPEIA (this issue).

RUTHVEN, A. G.
1912 On the breeding habits of Butler's garter snake. *Biol. Bull.*, 24: 18–20.
1915 The gestation period in *Thamnophis butleri* (Cope). COPEIA, 15.

SHIELDS, F. B.
1929 Notes on the young of *Storeria dekayi*. COPEIA, 171: 52–54.

TRAPIDO, HAROLD
1939 Studies on the taxonomy and natural history of the snakes of the genus *Storeria* in the United States and Canada. A.M. Thesis Cornell Univ. (Ms.)

WOODWARD, S. F.
1933 A few notes on the persistence of active spermatozoa in the African night adder, *Causus rhombeatus*. *Proc. Zool. Soc. London*, 1933: 189–190.

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Sperm Viability in the Uterus of the Garter Snake, *Thamnophis*

By HERMANN RAHN[1]

VARIOUS considerations of the physiology of gestation of our viviparous snakes, such as the formation and function of a yolk-sac placenta (Rahn, 1939) and the corpora lutea of the ovary (Rahn, 1938, 1939) demand more definite information concerning the gestation period and the time relation between mating and ovulation. The estimation of gestation

[1] This work was done during tenure of a National Research Council Fellowship.

periods in snakes has usually been based upon the observed time interval between mating and parturition, with the tacit assumption that mating and ovulation occur at approximately the same time.

The observations made here not only show a rather long survival of sperm *in utero* with maintenance of fertilization capacity, but also indicate that in the garter snake, and probably in most snakes, mating or insemination may be quite divorced from the ovulation period. The data lead further to the assumption that successful fall mating might easily take place with fertilization occurring the following spring. This view is greatly strengthened by the observations of Trapido (this issue of COPEIA) on the genus *Storeria*. These observations are brought to the attention of herpetologists at this time to enlist their interest on this fundamental but little explored problem of reptilian gestation.

MATERIAL

All observations were made on the garter snake, *Thamnophis s. sirtalis*. Between May 11 and May 20 nine females (Th. 50–Th. 58) were secured from the vicinity of Boston, Massachusetts, while the remaining 35 females (Th. 59–Th. 93) were collected on May 30, 1939, among the ruins of Louis Agassiz' first marine laboratory on Penekese Island off Cape Cod, Massachusetts. This group was apparently just scattering from their hibernating den on this rather cold and wet island in the Atlantic Ocean. All Penekese Island females were extremely large; only two small males were captured. Sexes were kept strictly separated throughout their whole captive existence.

METHODS

The presence of spermatozoa in the uterus was ascertained either by making smears of the uterine content or exploratory laparotomy. The uterine smear method is similar to the vaginal smear technique in mammals. The entrance to either uterus can be forced by gentle probing with a long metal probe, and the instrument may be inserted 10 to 15 cm. into the uterus (Figs. 1 and 2). By carefully withdrawing the instrument and mixing the clinging uterine mucous with a drop of Ringer's solution or a 0.7 per cent salt solution on a slide the presence of the rather large spermatozoa can easily be seen even at low magnifications (Fig. 3).

At first the animals were anesthetized for this procedure, but later when greater proficiency in placing the probe was acquired, the smears could be obtained easily from unanesthetized individuals. Four of the negative determinations after examination of forty-four animals proved later by operative methods to be incorrect. Consequently a negative determination may not always prove the absence of spermatozoa.

An operative technique (exploratory laparotomy) was employed later to check determinations made by the previous method. This can be done without sacrificing the animal. Anesthesia was produced by intraperitoneal injections of 0.5 per cent Nembutal as recommended by Clark (1937) and was found to be very satisfactory. Aseptic measures were not necessary. A small ventral incision through the body wall was made and the upper end of one uterus removed, placed on a slide with salt solution, and slit open. The

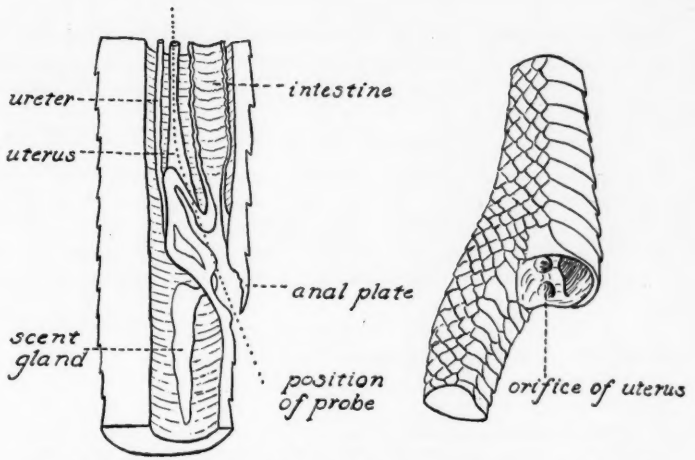

Fig. 1. Longitudinal section through cloacal region of female snake to show the placement of probe into the uterus.

Fig. 2. Caudal view of the distended cloacal chamber of female to show the relative position of the intestinal and uterine orifice.

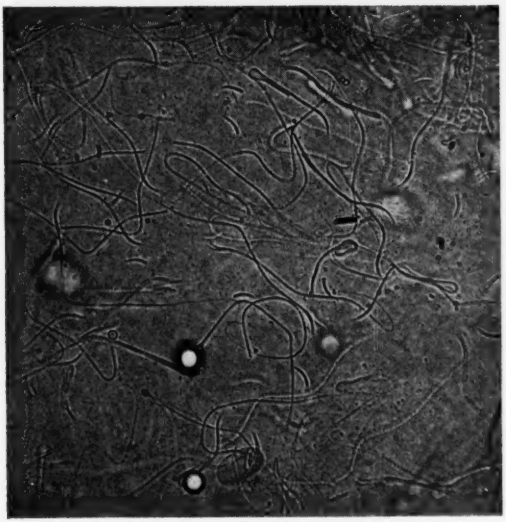

Fig. 3. Photomicrograph of a uterine sperm smear.

content of the uterus was washed out and readily examined under the microscope.

This method seems to be the most reliable for determining the presence of sperm and allows this operation to be repeated on the same animal from time to time. It may prove especially useful in the more exact determination of ovulation.

Sperm Survival *in Utero*

The uterine smear method was the first assay employed on all snakes coming into the laboratory. Of the nine females collected near Boston between May 11 and May 25, six showed the presence of motile spermatozoa in the uterus. Two others were immature and the remaining one, a very large specimen, revealed at later operation to have an apparently immature ovary.

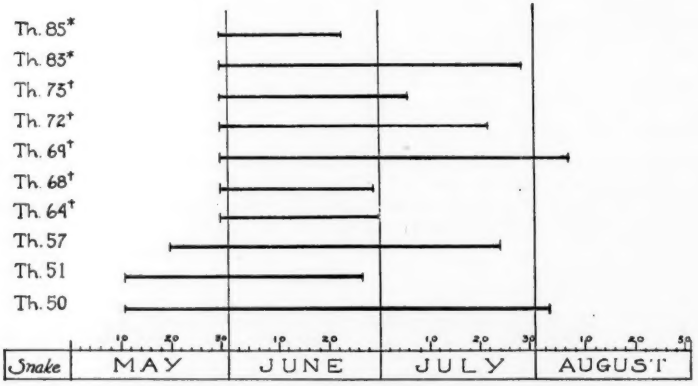

Fig. 4. Periods of viability of sperm in the uterus of ten isolated females.
* — sperm were not discovered at first examination. + and * isolated since May 30 although sperm test was not actually performed until June 6.

The remaining lot of females, all from Penekese Island, were examined on June 6. Since they were segregated from males at time of capture on May 30, all determinations of sperm survival *in utero* refer to that date.

Of the total of forty-four females examined, thirty-eight showed the presence of motile spermatozoa. Thirteen of the latter became pregnant. Observations of the embryos and corpora lutea by exploratory laparotomy indicated that ovulation must have taken place in the Penekese snakes during the month of June and in one in early July.

Most of the later determinations of the presence of sperm were made by the operative method. The case history of those non-pregnant animals in which motile sperm were actually observed more than once by one or the other technique is given below.

Live sperm found in snake:

Th.50 on May 11, June 27, August 3.
Th.51 on May 11, June 27.
Th.57 on May 20, June 28, July 24.

Th.64 on June 6, June 30.
Th.68 on June 6, June 29.
Th.69 on June 6, August 7.
Th.72 on June 6, July 27.
Th.73 on June 6, July 6.
Th.83 on July 29—no sperm discovered on 1st examination, June 6.
Th.85 on June 23—no sperm discovered on 1st examination, June 6.

These figures are recorded graphically in Fig. 4. The following is a list of dates indicating in some of the non-pregnant individuals the first time no sperm was found or when the spermatozoa present were non-motile.

Th.59 on October 23.
Th.62 on July 23.
Th.64 on August 1.
Th.65 on September 12.
Th.67 on June 29.
Th.78 on October 23.
Th.85 on July 22.
Th.105 on August 19 (a pregnant animal, 4 days after parturition).

The above data, of course, do not represent the earliest period of uterine sperm inactivity and death. If, however, these figures are considered in connection with the dates listed for viable sperm *in utero* they show clearly the increased mortality rate of spermatozoa in non-pregnant individuals, in the middle of the summer.

In this connection a recent observation of Dr. P. L. Risley of the State University of Iowa (personal communication) in regard to *Thamnophis s. parietalis* is of great interest. He writes: "The specimen was collected at Fairfield, Iowa, on October 28, 1939, and was autopsied December 9, 1939, after being kept in the laboratory in isolation for that period. Numerous motile spermatozoa were present in the middle and upper thirds of both right and left uteri. None were found in the upper membranous funnel regions and none were in the posterior ends near the cloaca." In view of further evidence (see below) it would seem that in this specimen a fall copulation was responsible for the presence of sperm at this time of the year.

Fertilization Capacity of Aged Uterine Sperm

Since motility does not necessarily indicate that spermatozoa still retain their fertilization capacity, the case-history of the Penekese snake Th.68 is significant. Segregated from any male since May 30, sperm was detected by the uterine smear method on June 6. Exploratory laparotomy on June 29 revealed motile spermatozoa in the left uterus and showed that the animal was near ovulation. Several developing embryos were found in this animal by operation on July 17.

Although this is only a single observation, it indicates clearly that in *Thamnophis s. sirtalis* sperm aged *in utero* for one month still retains its fertilization capacity.

Discussion

These direct observations show clearly that spermatozoa may retain their motility in the uterus of the snake for at least three months and very probably longer, since the matings might have occurred long before capture. This offers an interesting contrast to observations on mammalian spermatozoa, which, except in the case of bats, retain their viability for only a few days in the female. In the bird spermatozoa will live somewhat longer, up to two

and three weeks. The only other direct observations on snake sperm viability have been made by Gloyd (1933) who found that in the copperhead spermatozoa "may live within the body of the female eleven days and perhaps considerably longer." The factors which aid the continued viability of sperm in the reptilian uterus are unknown, yet experiments on mammalian and avian sperm have shown that pH, high CO_2 tensions, and temperature play an important rôle (see Hartman, 1939, for review of this whole problem).

The incidence of motile spermatozoa in the uterus of the females examined is high. Living spermatozoa are present in 90 per cent of the total of forty-two females. Only 34 per cent of this group actually ovulated and became pregnant. This emphasizes again, in contrast to most amphibians, birds and mammals, that mating in snakes is not necessarily associated with ovulation or near ovulation, nor is the endocrine basis for a mating urge associated with follicular growth. This becomes especially clear where matings in the fall and during pregnancy have been reported. *Thamnophis radix* has been observed to mate in September (Coues and Yarrow, 1878). Trapido (this issue of COPEIA) records fall mating for *Storeria* and Noble (1937) cites from the literature this phenomenon for four other species of snakes and matings which took place during pregnancy for five species. Further, there are the many cases under observation in which the author found an abundance of motile spermatozoa in large mature females with very small ovaries, almost immature in appearance.

The fallacy in estimations of the gestation period by the observed time interval between mating and parturition now seems obvious, since the interval between mating and fertilization may be several weeks.

The fact that the fertilization capacity can be retained by sperm *in utero* for at least one month is rather significant. This may be a possible safety factor which insures fertile eggs regardless of the time of ovulation. In populations in which males are scarce or in which the chances of close proximity of males and females are reduced after scattering from the hibernating den this factor assumes added significance. Two indirect observations on the fertilization capacity of sperm aged in the oviduct strengthen this view. Woodward (1935) reports that an isolated female African night adder (*Causus rhombeatus*) laid several clutches of fertile eggs at definite intervals from April 26 until July 13 and infertile eggs thereafter. Hildebrand's observations on the turtle (1929) show that isolated *Malaclemmys centrata* females deposited fertile eggs four years in succession.

With the possibility of long sperm survival the direct and indirect evidence for fall mating (Coues and Yarrow, 1878; Risley, *supra*; Trapido, 1940; and Noble, 1937) has added significance. The dissection of seminiferous tubules and vas deferens of several male garter snakes during the month of August showed an abundance of mature and motile spermatozoa, indicating spermatogenic activity at this time of year. It would seem then, that after fall copulation spermatozoa might survive in the uterus until the next spring and would be able to fertilize eggs upon ovulation. The decrease of the body temperature of the female during hibernation would promote sperm survival, as has been amply shown in physiological studies of mammalian and avian sperm.

Summary

Two methods are described for the determination of motile spermatozoa in the uterus of snakes.

Of forty-two mature female garter snakes (*Thamnophis s. sirtalis*) examined in May and June, 90 per cent revealed the presence of motile spermatozoa in the uterus. Only 34 per cent of this number became pregnant. In ten non-pregnant individuals motile spermatozoa were recovered at various intervals up to three months after isolation from any male. One case history demonstrated clearly that uterine sperm retains its fertilization capacity for at least one month.

It is thus shown that in snakes and turtles, in contrast to most higher vertebrates, the act of mating and ovulation may be divorced by a time interval of several weeks or longer. The estimation of the gestation period in snakes cannot be based upon the observed period between copulation and parturition.

It is believed that the long survival of sperm *in utero* may be a safety factor insuring fertile eggs in absence of a male at time of ovulation, and that effective fall-mating with fertilization occurring in the spring may be quite possible.

Literature Cited

Clark, H.

1937 Embryonic series in snakes. *Science*, 58: 569–570.

Coues, Eliott and H. C. Yarrow

1878 Notes on the herpetology of Dakota and Montana. *Bull. U. S. Geol. and Geogr. Surv.*, 4: 259–291.

Gloyd, H. K.

1933 Studies on the breeding habits and young of the copperhead, *Agkistrodon mokasen* Beauvois. *Pap. Mich. Acad. Sci., Arts, Lett.*, 19: 587–604.

Hartmann, C. G

1939 Ovulation, fertilization and the transport and viability of eggs and spermatozoa. Chap. IX. Allen, Danforth and Doisy, *Sex and Internal Secretion*. Baltimore, Williams and Wilkins, 2nd ed.

Hildebrand, S. F.

1929 Review of experiments on artificial culture of diamond back terrapin. *Bull. U. S. Bureau of Fisheries*, 45: 25–70.

Noble, G. K.

1937 The sense organs involved in the courtship of *Storeria, Thamnophis* and other snakes. *Bull. Am. Mus. Nat. Hist.*, 73: 673–725.

Rahn, Hermann

1938 The corpus luteum of reptiles. *Anat. Rec.*, 72, Suppl.: 55.

1939 Structure and function of placenta and corpus luteum in viviparous snakes. *Proc. Soc. Exp. Biol. and Med.*, 40: 381–382.

Trapido, Harold

1940 Mating time and sperm viability in *Storeria*. Copeia (this issue).

Woodward, S. F.

1933 A few notes on the persistence of active spermatozoa in the African night adder, *Causus rhombeatus*. *Proc. Zool. Soc. London*, 1933: 189–190.

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Delayed Fertilization in *Leptodeira annulata polysticta*[1]

By T. P. Haines

A FEMALE specimen of *Leptodeira annulata polysticta* Günther, taken from a bunch of bananas in March, 1934, in Detroit, Michigan, and presumably from Central America, came into my possession in August of that year. This snake, the only one of its species in my possession, is still living. It has been kept continuously in a small cage, isolated from other snakes. It has thriven in captivity, feeding on lizards and frogs, and growing from 750 mm., when captured, to 960 mm. at the present time. The fact that this specimen, long isolated from any contact with a male, has continued to lay fertile eggs contributes evidence on what appears to be a problem of broad biological importance.

On March 20, 1936, a clutch of seven eggs was found in the cage. They were in a shrunken condition, indicating that they had been laid several days previous to their discovery. They were thin-shelled, leathery in texture, and uniformly light creamy white in color, and when inflated with 10 per cent formalin were found to average 28.9 x 12 mm. in size. In one of the eggs a small red area was seen through the shell but this disappeared after preservation.

Careful watch for eggs during March, 1937, was fruitless, as were also the observations in March, 1938. After I had given up hope that it would lay any more eggs I found a clutch of six on May 6, 1938. These were very similar to those of 1936 except they were on the average smaller, being 25.7 x 10.8 mm. in size. In this clutch two of the eggs showed a red area beneath the shell.

In March, 1939, the snake was examined externally and was found to possess eggs. Daily check was made to discover the exact date of laying and to insure that the eggs would be secured in a freshly laid condition. On March 10 one egg in a shrivelled condition was passed. On March 22 another egg was laid. On March 28 the remainder of the complement of nine eggs was laid. Again the eggs were smaller than in previous years but the number was greater, perhaps accounting for the smaller size. The average size of the third clutch was 23.7 x 11.83 mm. In six of the eleven eggs the previously mentioned red area was noted. This area, which was found by microscopical examination to be the area vasculosa, averaged 3.5 mm. in diameter. The eggs were placed in a moist chamber for possible development, but conditions were unfavorable and they eventually spoiled. Some of the eggs had been opened at successive intervals and the germinal area removed, fixed in Bouin's fluid and afterward sectioned.[2]

Measurements of the individual eggs in the several clutches are represented in the accompanying graph. Each mark represents the length and width of one egg. The average of the eggs of the three clutches was 26.12 x 11.54 mm.

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[1] Contribution from the Department of Zoology, University of Michigan.

[2] At the time of publication the snake had laid 13 eggs in 1940, from May 7 to 14. These eggs averaged 21.1 x 11.8 mm. Five of the ten eggs opened showed some embryonic development; from two of these five, living embryos were recovered. This material will form the basis of a future article.

It is interesting to note that the average widths remained approximately the same but the average length became shorter with each successive clutch. This compares with observations by Blanchard (1936) on the eggs of the eastern ringneck snake. He states that, "Within any single clutch the eggs tend to be uniform in size, proportion and appearance. Small clutches are likely to be composed of long eggs and large clutches of short eggs."

In cross-section the germinal area showed a great proliferation of cells. In two of the blastoderms a central portion showed an enlarged structure representing the remains of an embryo, but disintegration had taken place and definite structures were no longer recognizable. In only one of the six eggs that possessed the area vasculosa was a living embryo observed. Superficially this embryo appeared normal and comparable to the embryos of *Thamnophis, Heterodon,* and *Elaphe* of a similar age and development. It measured 4 mm. in length, the body was already coiled, and it was approximately of the same stage of development as a 48-hour chick.

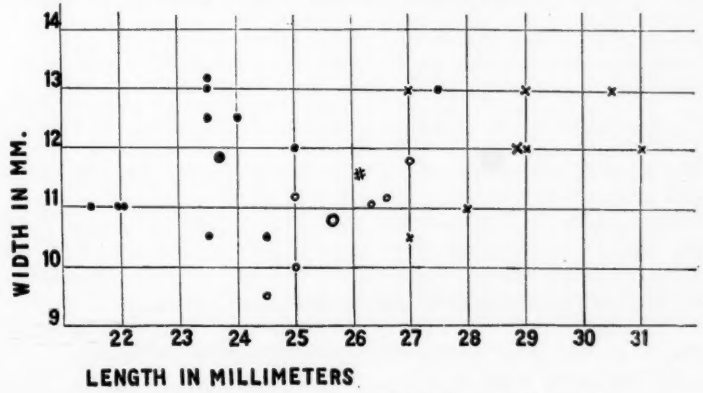

Figure 1.—Dimensions of eggs of *Leptodeira annulata polysticta*

Those marked x are from the clutch of 1936, those marked o from the clutch of 1938, and those marked ● from the clutch of 1939. The enlarged symbols represent the average size of each clutch and the # is the average of all the 24 eggs.

The question arises whether this case represents one of parthenogenesis or one of delayed fertilization. Normal parthenogenesis has not been recorded for higher vertebrates, but several instances of what appear to be longevity of the sperm are on record. Hildebrand (1929) showed that in the diamondback terrapin, *Malaclemmys,* annual copulation was not necessary, since females produced fertilized eggs after four years of isolation, although with marked decrease in fertility after the second year. Woodward (1933) reported on an isolated specimen of the night adder *Causus rhombeatus,* which laid seven clutches of eggs at monthly intervals, finding that the per cent of fertility decreased after the second clutch and apparently stopped after the fourth. Kopstein (1938)[3] describing the eggs and reproductive habits of Malayan reptiles summarizes his observations as follows:

[3] Summary included to make information more readily available to persons who might be interested in these facts.

(1) An isolated female of *Natrix vittata* laid on the 26th of March, 1935 and on the 3d of May of the same year each time 8 eggs. From both ovipositions the young ones hatched.

(2) Another *N. vittata* female laid on the 31st of May, 1935, 5; and on the 27th of September of the same year, 6 eggs. Both layings had a complete development. This female laid fertilized eggs during the following 1½ years at intervals of 4–5 weeks, but they were destroyed in an early stage of embryonic development . . . .

(3) A female of *Natrix subminiata* laid on the 9th of July, 1934, 5 fertilized eggs, on the 2d of October and on the 15th of November of the same year, 5 eggs again. After that only unfertilized eggs were laid.

(4) Another *subminiata* female laid on the 28th of June, 1935, 9 unfertilized eggs and, in spite of isolation, on the 21st of August of the same year 10 eggs which were fertilized, and out of which the young ones hatched.

(5) The 5th example is given of a specimen of the genus *Boiga*. An isolated female of *Boiga multimaculata* laid on the 5th of May, 1934, and on the 1st of January, 1935 each time 4 eggs. From all of the eggs the young ones hatched. After that only unfertilized eggs were laid.

(6) A second, also isolated *multimaculata* female laid on the 22d of October and on the 21st of December, 1936 each time 4 eggs. From the first of the ovipositions 4 young hatched. The observation of the second laying is at the writing of this publication not yet finished, but the eggs are without doubt fertilized as the embryos can already be seen when the eggs are illuminated.

Because it is proved that this kind of fertilization was not known in the reptiles and because the physiological process has no scientific name it is here called *amphigonia retardata*.

In addition to these records Blanchard[4] (in MS) has indisputable evidence of successful autumnal matings in *Thamnophis s. sirtalis*.

It is entirely possible that this method of reproduction is normal and more common than has been reported. At least in view of similar cases among other cold blooded vertebrates it is possible that snake sperm may live for a considerable length of time in the body of the female.

The specimen of *Leptodeira* in my possession is too interesting to warrant killing in an attempt to find living sperm in its reproductive ducts.

The present observations on a specimen of *Leptodeira a. polysticta* record the production of fertile eggs at least five years after the last possible copulation. This is the longest record of its kind known for reptiles.

Literature Cited

BLANCHARD, F. N.
1937 Eggs and natural nests of the eastern ringneck snake, *Diadophis punctatus edwardsii*. *Pap. Mich. Acad. Sci., Arts, and Letters*, 22: 521–532.

DUNN, E. R.
1936 Notes on North American *Leptodeira*. *Proc. Nat. Acad. Sci.*, 22 (12): 689–698.

HILDEBRAND, S. F.
1929 Review of experiments on artificial culture of diamond-back terrapin. *Bull. U. S. Bureau of Fisheries*, Doc. No. 1060, 45: 25–70.

KOPSTEIN, F.
1938 Ein Beitrag zur Eierkunde und zur Fortpflanzung der Malaiischen Reptilien. *Bull. Raffles Mus.* 14: 81–167.

WOODWARD, S. F.
1933 A few notes on the persistence of active spermatozoa in the African night adder, *Causus rhombeatus*. *Proc. Zool. Soc. London*: 189–190.

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[4] Grateful appreciation is expressed to Dr. F. C. Blanchard for permission to publish this information.

Autotomy of the Tail in Permian Reptiles

By Llewellyn I. Price

THE transverse cartilaginous septa associated with autotomy and found in the caudal centra of various existing lizards and *Sphenodon* were long ago observed in two Jurassic genera *Homeosaurus* and *Saphaeosaurus* (=*Sauronodon*), the former a typical rhynchocephalian and the latter a primitive diapsid which may belong to the same order. We wish to record the presence of this condition in a very different group of reptiles, and one much more remote geologically—the family Captorhinidae of the Cotylosauria or "stem reptiles." These forms flourished in the oldest of the adequately known reptilian faunas, that of the Permo-Carboniferous "redbeds" of the American Southwest.

Fig. 1. Caudal vertebrae of *Captorhinus* from a specimen in the University of Oklahoma, No. 1020. The second sacral vertebra and the first five caudals are seen in ventral aspect, the remainder in lateral view. The septum appears first in the seventh caudal. X2.

The split centra are found in three genera: *Captorhinus, Labidosaurus* and an undescribed genus close to the latter. In an articulated specimen of *Captorhinus* the septum is first observed in the centrum of the 7th caudal vertebra. This vertebra differs markedly from those preceding it in that the transverse process is vestigial whereas in the 6th it is pronounced and obviously carried a prominent caudal rib. The septum bisects the notochordal centrum transversely and is easily traceable along the ventral surface, becoming less distinct laterally where the pedicels of the neural arch descend to gain attachment with the centrum.

The discovery of the septum in such ancient reptiles might be thought to lend support to Albrecht's belief that this indicates the point of division between basi- and interventral divisions of the primitive vertebra. This, however, is not the case, for in the captorhinids the basiventral is present as the intercentral element forming the chevron, and both halves of the true centrum are obviously of interventral origin. Nor does the presence of a mechanism for autotomy in this group indicate that this structure was characteristic of primitive reptiles in general, for the tail is adequately known in representatives of most major reptilian types of the "redbeds" and

the septum is definitely absent in all other cases, including the protorosaur *Ophiodeirus*.

This discovery is, however, of considerable phylogenetic interest. Williston believed the Squamata to have been derived from the Protorosauria, forms with a single upper temporal opening, exemplified by *Araeoscelis*. But Peyer's work on the reptiles of the Alpine Triassic shows that the protorosaurs were evolving in a direction quite different and apparently had nothing to do with lizard ancestry. Broom is a prominent recent advocate of an alternate theory, which has much to support it—that the lizards are related to the Rhynchocephalia, and like them have sprung from primitive diapsids, the Eosuchia of the late Permian and Triassic. These forms in turn must have arisen from cotylosaurian ancestors in earlier times. It was, however, impossible to determine which, if any, of the known cotylosaurs gave rise to the primitive diapsids, since most of the emphasis of the discussion has been placed on the temporal fenestrae, and such fenestrae are by definition absent in the "stem reptiles."

The Captorhinidae are advanced cotylosaurs whose structure has been described by Case, Williston and others. Watson believed them to be closely related to the ancestry of mammal-like reptiles. The writer has, however, pointed out in previous papers that, while there do exist advanced cotylosaurs apparently related to the synapsids, the Captorhinidae do not exhibit significant theromorph features, and that the braincase structure is closely comparable to that in *Sphenodon* and the more generalized lizards. The presence of the mechanism for autotomy in the Captorhinidae furnishes further evidence for the belief that the family may be close to the ancestry of the basic diapsid stock.

Almost nothing is known of the tail in the Eosuchia of the later Permian and Triassic, a group which, it is suggested, formed the link between the captorhinids and the modern orders. It is reasonable to predict that when better known the caudal centrum septum will be found in these transitional types.

MUSEUM OF COMPARATIVE ZOOLOGY, CAMBRIDGE, MASSACHUSETTS.

Amphibians and Reptiles from Garrett County, Maryland

By ROBERT H. MCCAULEY, JR., AND CHARLES S. EAST

DURING the seven days between the 5th and 12th of September, 1936, the writers collected amphibians and reptiles in the extreme western portion of Garrett County, Maryland. All the areas visited were considerably west or south of Jennings, where specimens were collected by Keim (COPEIA, 1914) and Fowler (COPEIA, 1925). The amount of material obtained was further increased by specimens presented by Mr. Leonard Llewellyn and Mr. J. T. Rothrock.

The 326 specimens of amphibians collected are now in the collection of the U. S. National Museum. More than fifty specimens of reptiles were obtained. These will be divided between the collections of Cornell University and the U. S. National Museum.

Garrett County is extremely mountainous throughout. The altitudes at points where collections were made range from 1,400 to nearly 3,000 feet. The entire area lies within the Alleghanian Fauna of the Transition Zone, with the exception of small Canadian Zone areas at the higher altitudes in the extreme west. The localities visited are underlain by carboniferous shales, sandstones or conglomerates, and sometimes coal.

The specimens noted were taken from the following localities:

1. Near bridge along U. S. Route 219 over South Branch of Bear Creek, near McHenry; alt. 2,300-2,400 ft., Ohio River drainage.
2. Near Lakewood M. E. Church west of Sang Run; alt. 2,300 ft., Ohio River drainage.
3. Sang Run, CCC Camp S67; alt. 2,800-2,900 ft., Ohio River drainage.
4. Muddy Creek, near Sang Run; alt. 2,400-2,500 ft., Ohio River drainage.
5. Big Run Flat, Savage River, near Westernport; alt. 1,400-1,500 ft., Potomac River drainage.
6. Deep Creek Lake; alt. 2,100 ft., Ohio River drainage.
7. Swanton; alt. 2,290 ft., Potomac River drainage.

List of Species

Cryptobranchus alleganiensis (Daudin).—Mr. J. T. Rothrock, Superintendent of CCC-S67 reports that "hellbenders" are caught on hook and line by fishermen in the Youghiogheny River. No specimens were seen by the writers.

Triturus viridescens viridescens (Rafinesque).—One of the most common amphibians of the region. The sub-adult form was extremely abundant at McHenry, at the north end of Deep Creek Lake. As many as eight or ten were often found under one log. Adults were observed clasping in a pond near U. S. Route 219 at Bear Creek.

Hemidactylium scutatum (Schlegel).—One large specimen was collected under a rather dry piece of bark in a low marshy meadow, south of White's Knob.

Plethodon cinereus (Green).—A common species. All individuals seen or collected were of the red-backed form. These specimens were quite unstable in color, the dorsal band varying from a washed out yellow to typical red.

Plethodon glutinosus (Green).—Common on damp hillsides. All specimens are either very sparsely spotted on the back, or lack dorsal spotting entirely, while the sides are very profusely spotted. The costal groove count is 14 or 15.

Gyrinophilus porphyriticus porphyriticus (Green).—Found in all the colder springs and streams at the higher levels. One larval specimen 62 mm. in length was taken from a spring near the mouth of Savage River and another measuring 97 mm. was taken in Monroe Run.

Pseudotriton ruber ruber (Sonnini).—One large adult was taken among chips at an old sawdust pile near Sang Run P. O.

Eurycea bislineata bislineata (Green).—A not uncommon species. Specimens were taken or observed at nearly all points visited.

Eurycea longicauda longicauda (Green).—This species is quite common in the valleys, but is not met with on the slopes of the mountains. Two large adults were taken from the heart of a rotten hemlock log at Bear Creek.

Desmognathus fuscus fuscus (Rafinesque).—The least common species of *Desmognathus* at any point visited. It occurs in the same streams as *D. o. ochrophaeus,* but shows no signs of intergradation.

Desmognathus ochrophaeus ochrophaeus (Cope).—This is the most characteristic salamander of the region. It is to be found in almost every stream and spring. The color pattern variation ranges from one similar to that of *E. b. bislineata* in young specimens to that of *D. f. fuscus* in old adults.

Desmognathus phoca (Matthes).—A very common species, met with in the same situations as *D. o. ochrophaeus.*

Bufo americanus americanus (Holbrook).—Common throughout the county, and observed both on the mountain tops and in the valleys.

Hyla crucifer Wied.—Single individuals were heard calling at practically every point visited.

Rana clamitans Latreille.—Every spring, pond, and stream has its quota of this species.

Rana palustris Le Conte.—Abundant in the valleys.

Rana sylvatica sylvatica (Le Conte).—One medium sized adult was taken along Monroe Run.

Diadophis punctatus edwardsii (Merrem).—Three were taken. The first was beneath a stone along Bear Creek, near U. S. Route 219, near McHenry. The other two were beneath stones near Big Run Flat along the Savage near Westernport. One disgorged a very large *Plethodon glutinosus.*

Opheodrys vernalis (Harlan).—Two specimens taken by CCC workers at Sang Run during the early summer were presented to the writers by Mr. J. T. Rothrock.

Elaphe obsoleta obsoleta (Say).—One taken near Sang Run by CCC workers during the summer was presented to the writers by Mr. J. T. Rothrock. Another, taken near Swanton, September 10, 1936, was received from Mr. Llewellyn.

Lampropeltis triangulum triangulum (Lacépède).—Two taken near Sang Run by CCC workers were presented to the writers. A third specimen from near Swanton was collected by Mr. Llewellyn.

Natrix septemvittata (Say).—This snake was very common at two places. Two were taken from the swift flowing South Branch of Bear Creek along U. S. Route 219 near McHenry. Six were collected from the more sluggish Muddy Creek at one locality. Most of these were very small. They were found beneath loose stones at the edge of the stream or in the branches of overhanging bushes.

Natrix sipedon sipedon (Linnaeus).—The common watersnake was abundant at all points observed. Most were rather small and were found beneath stones or in or near the water at the edges of streams. Others were observed in the branches of low, overhanging bushes. In the most unique instance, a 30-inch specimen was found covered with ants, beneath a board, stretched out in an old mouse run. Other specimens were given to the writer by Mr. Rothrock. Two collected at Deep Creek Lake were presented by Mr. Llewellyn.

Storeria occipitomaculata (Storer).—Only one was seen, taken beneath a board in a damp meadow bordering a small hemlock grove a short distance from the Lakewood M. E. Church near Sang Run. This is a flat locality of considerable altitude where a small, sluggish, meandering stream passes alternately through areas of open meadow and dense shrubbery.

Storeria dekayi (Holbrook).—Two, a male and female, were found beneath a single stone beside a small pond in a marshy meadow near the northern end of Deep Creek Lake at McHenry. Each individual was neatly coiled. They lay sufficiently close together to be covered by one hand.

Thamnophis sirtalis sirtalis (Linnaeus).—One of the most common snakes. Specimens were taken at nearly every locality. They seemed partial to damp localities along water courses. One was found inside a very damp rotten log.

Crotalus horridus horridus (Linnaeus).—Many were taken or destroyed by CCC camps throughout Garrett County. The species is apparently quite common in the unsettled mountainous regions. Three taken near Sang Run early in the summer were presented to the writers.

Chelydra serpentina (Linnaeus).—Two specimens were taken from Muddy Creek about a mile from the Lakewood M. E. Church near Sang Run. It is doubtless common in all the streams of the region.

Chrysemys picta ssp.—Five of various sizes were taken from two small ponds in a marshy meadow near McHenry. They are obviously intergrades between *picta* and *marginata*. The costal plates in all show a marked tendency to alternate with the vertebrals. This is especially striking in three specimens. Each has distinct dark blotches on the plastron, but in only two (included in the above three) are the blotches large enough to be considered typical of *marginata*.

Literature Cited

Bishop, S. C., and F. J. W. Schmidt
1931 Painted turtles of the genus *Chrysemys*. *Zool. Ser. Field Mus. Nat. Hist.*, 18: 121–139, figs. 1–27.

Fowler, H. W.
1925 Records of amphibians and reptiles for Delaware, Maryland and Virginia. II. Maryland. Copeia, 61–64.

Keim, T. D.
1914 Amphibians and reptiles at Jennings, Maryland. Copeia, 2: [2].

Stejneger, L. and T. Barbour
1939 A check list of North American amphibians and reptiles. Fourth ed.: xvi+207.

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Observations on the Reproductive Behavior of the Snapping Turtle

By W. J. Hamilton, Jr.

THE breeding habits of the snapping turtle, *Chelydra serpentina,* have recently been well summarized by Cahn (1937) and Pope (1939). These accounts indicate that our knowledge of the breeding habits of this abundant and widespread reptile are by no means completely known. Accordingly, I venture to present some observations on the reproductive behavior of this turtle which appear interesting and previously unreported.

On May 1, 1929, my wife and I were searching roadside pools for breeding frogs some 11 miles northeast of Ithaca, New York. Our attention was directed to a commotion in a shallow semi-permanent pool near the highway. Closer inspection proved the cause of this disturbance to be a pair of mating snapping turtles. The snappers, usually wary at other seasons, seemed quite unconcerned when we approached them for more detailed observation. The male, with a carapace length of 9 inches, was considerably smaller than the female. He maintained his position largely by grasping the front edge of the female's carapace with his stout claws and his tail curled beneath the plastron of the female so that the vents opposed one another. The female carried him about as she moved slowly through the pool. The water was scarcely 8 inches deep, so that the head and foreparts of the male could be seen from some distance. They remained *in copula* for twenty minutes as we waded close by but, finally taking alarm, the larger female in some manner shook loose from the male and made off rapidly. Conant (1938) remarks that captive snapping turtles in coitus maintain their plastrons in parallel planes with the plastron of the male pressed tightly against the carapace of the female, the claws of all four feet of the male hooked under the edge of the female's carapace. Mating in captivity occurred from April to October and no season of particular activity was noted.

In central and western New York, snapping turtles usually deposit their eggs during the first to third week of June. On June 17, 1926, near Wellsville, Allegany County, New York, I surprised a large female presumably in search of a suitable nesting site. This turtle contained twenty-three well developed eggs in the oviducts with fully formed shells and a number of smaller eggs about the size of marbles which presumably would not mature until the following spring. On June 11, 1936, I collected a snapping turtle with 10-inch carapace near Ithaca, New York, which was searching for a suitable place for egg deposition. I removed seventeen fully developed uterine eggs from this turtle. In addition I have records of turtles with fully formed uterine eggs in the oviducts from May 23 to June 20. They number, for eight turtles examined, 12, 18, 21, 22, 25, 26, 30 and 30 respectively. These turtles had a carapacic length of 8 to 12 inches. Surface (1908) states that "from twenty to one hundred [eggs] may be laid in one nest, according to the size of the female." The egg complement as given by Hay (1892) varies, "from 30 to 70." These records of unusually large numbers are probably based on conjecture.

A snapping turtle with 12-inch carapace was presented to me on June 13, 1939. The oviducts of this turtle contained nineteen fully developed eggs which were apparently ready for deposition, for the turtle was collected under circumstances which suggested that she was searching for a nesting site. On the same day these eggs were buried from 4 to 12 inches deep in the soil of my garden. Half were placed in relatively moist situations, while the remainder were deposited in a higher and considerably drier section of the garden. The sites were marked with numbered stakes. A few were dug up at regular intervals, but none hatched until September 23, when a majority of the eggs were partly opened. All of the young turtles left the eggs on September 24, 1939. In this instance the incubation period required 102 days.

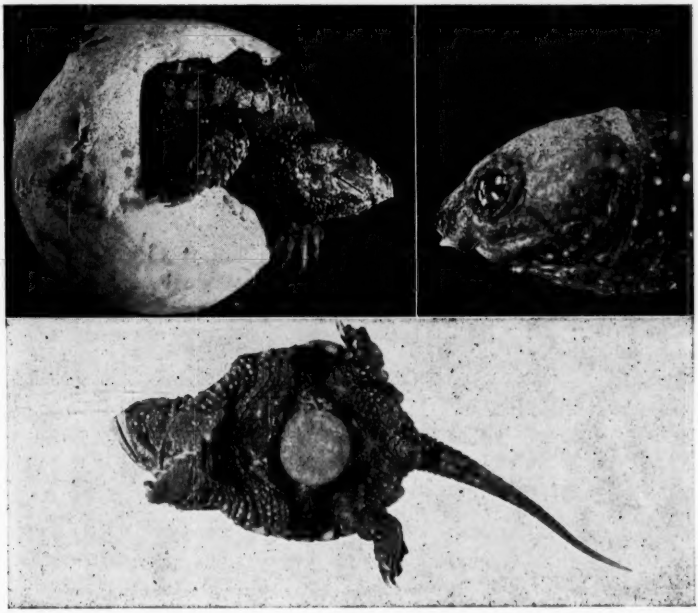

Fig. 1. Upper left, young snapping turtle emerging from the egg; upper right, the prominent white egg tooth of a recently hatched snapper; lower, the yolk sac persisting a day after hatching.

I suspect this is not far from the average incubation period. On the Montezuma Marsh, 50 miles east of Rochester, New York, snapping turtles normally lay their eggs between June 10 and June 20. On September 21, 1939, I tramped over several miles of the drought-stricken swamp and found a number of newly hatched snappers, their backs still covered with the dry dirt from their natal chamber. This would place the incubation period between

100 and 110 days. In northern latitudes the eggs may not hatch until the following spring. During mid-September, 1928, I was shown a nest of a snapping turtle on the sandy shore of a large lake on the slopes of Mt. Katahdin, Maine. Examination of the eggs proved the developing turtles to be in a relatively unadvanced stage for that season, and the young surely would not have hatched until the following spring.

The young turtles are provided with a small white egg tooth, scarcely a millimeter long, attached between the tip of the snout and the cutting edge of the upper jaw (Fig. 1). With this sharp instrument a line is cut halfway around the middle of the shell and the young turtle forces its way out. A prominent yolk sac, from 7 to 10 mm. in diameter, remains attached to the center of the plastron. This is usually absorbed within twenty-four hours, but may persist for three days in captive specimens. The egg tooth is evident for three or four weeks after hatching. Newly hatched snapping turtles vary little in size; the measurements of five average: total length, 82 mm.; tail, 35 mm.; length of carapace, 30.5 mm.; width of carapace 29.

Newly hatched snappers are much more brightly marked than the adults. There is a row of tiny white tubercles on the chin; additional tubercles on the fore limbs are creamy white, this color also appearing on the marginals on their ventral surface. It is present also in small blotches on the cephalic and caudal borders of the plastron.

Very shortly after hatching, the young turtles shed their skin. The skin is cast in two pieces, that of the fore part, including the head, forelimbs (even the hard covering of the claws) and the forward part of the plastron consisting of one part, while the cast skin of the tail, hind limbs and caudal portion of the plastron form the other section. The plates of the carapace are not shed.

The eggs and young turtles are beset by many enemies. A large number of nests are opened by skunks, raccoons and foxes shortly after the eggs are deposited. During a visit to the Montezuma Swamp in late September I collected considerable numbers of raccoon and mink scats, several of which contained the recognizable remains of small snapping turtles.

Literature Cited

Cahn, A. R.
1937 The turtles of Illinois. *Univ. Ill. Bull.*, 35: 1–218.
Conant, Roger
1938 The reptiles of Ohio. *Amer. Midl. Nat.*, 20: 1–200.
Hay, O. P.
1892 The batrachians and reptiles of the state of Indiana. *Ann. Rept. Dept. Geol. Nat. Res. Indiana*, 17: 406–610.
Pope, C. H.
1939 Turtles of the United States and Canada. New York, Knopf: 1–343.
Surface, H. A.
1908 Economic features of the turtles of Pennsylvania. *Zool. Bull. Div. Zool., Penn. Dept. Agr.*, 6: 106–195.

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Herpetological Notes

TWO AMPHIBIANS NEW TO THE HERPETOFAUNA OF WEST VIRGINIA.—Recent herpetological investigations in the extreme southwest portion of West Virginia have done much to increase our knowledge of the forms that occur within this state. We plan to publish a list of the herpetofauna of this region, but have prepared the following advance report of a salamander *Ambystoma texanum* (Matthes), and a frog, *Scaphiopus holbrookii holbrookii* (Harlan), new to the state.

One specimen of *Ambystoma texanum* (CM 17578) was found under a board near a pond at Buffalo, Wayne County, and all efforts to find more specimens have been unsuccessful. This is the first time this species has been taken in West Virginia; Bond's record of it in Monongalia County (COPEIA, 1931: 53) was due to a mistake in identification.

Scaphiopus holbrookii holbrookii (Harlan) was first heard calling April 16, 1939, at two A.M. in the residential section of Huntington, Cabell County. This emergence was preceded by two days of heavy rainfall and followed by three more. During the first three days, April 14, 15, and 16, a total of 5 inches of rain fell. At this time three clasping pairs were taken from under water in a flooded field. The males did not release the females when picked up but persisted in their characteristic inguinal amplexus even when taken indoors and placed in jars of water. Many males were calling where these were taken, while others could be heard calling over that section of the city. The calling males observed were floating at the surface with their legs outstretched. At nine A.M. of the same day no toads could be found, although numerous egg masses were observed attached to the dead weed stalks in the water. That afternoon a systematic search of several flooded areas revealed many eggs, but no toads except at one large pool, about 100 by 75 feet and 18 inches deep, where boys were throwing stones at the toads as they came up for air. Specimens that had been killed were lying at the edge of the pool.

From eight to ten P.M. of the same day we collected thirty-six specimens, of which thirty-two were males. As we waded toward them they sank out of sight, but we could usually capture them by feeling along the bottom of the pool at the place where they had disappeared. By standing on the edge of the pool and flashing our head lamps over the water we could easily spot the ruby-red shine of their eyes, and in this manner we estimated that there were at least one hundred individuals in this small pond. The chorus reached its peak about eleven o'clock and showed no signs of slacking at midnight, when our observations ceased.

On the following night, April 17, observations were made on this colony as well as on a larger one in nearby Wayne County. The latter colony was breeding in a flooded golf course and an adjoining marshy field. Here the chorus seemed to be at its height, while at Huntington it had greatly diminished from that of the previous two nights. No toads were seen or heard after April 17.

The colonies were breeding in temporary rain pools in clay soil of the Ohio River plain and less than a mile from the river. Both colonies were situated close to well-traveled highways, railroad tracks, and dwellings. Both areas had been under cultivation or served as playgrounds in recent years. The Huntington colony was located within eight blocks of the business center in a city of 80,000. We were told by people living near this colony that the toads had appeared in previous years and sometimes more than once a season, always following heavy rains when the field would be flooded. Although several permanent ponds in this area were visited April 17, no toads were heard calling in any of them.

By May 3, all the pools were dry and there was no evidence that the drying hastened metamorphosis. Since those that developed in the laboratory did not begin transforming until May 16, it is probable that all of this brood was killed by the rapid drying of the ponds.

The *Ambystoma* and twenty specimens of *Scaphiopus* have been deposited in the Carnegie Museum.—N. BAYARD GREEN and NEIL D. RICHMOND, *Marshall College, Huntington, West Virginia.*

NOTES CONCERNING TWO BROODS OF YOUNG OF *NATRIX COMPRESSICAUDA*.—Comparatively little has been recorded about the flat-tailed water snake, *Natrix compressicauda* (Kennicott). Barbour and Noble (1915, Proc. Acad. Nat. Sci. Phila., 67: 29–35) state that the range is from Tampa Bay to Key West, Florida. They conclude that but one race of *Natrix compressicauda* can be recognized.

During 1939 the author observed in the field many specimens of *N. compressicauda* that were of a henna-red color. Although this color does not agree with most accounts in the literature, Barbour and Noble *(loc. cit.)* cite a letter from Mr. A. G. Reynolds, of Gulfport, Florida, that reads as follows:

> I have never found it anywhere except in brackish or salt water. Its local name is the "salt-water moccasin." The fishermen occasionally find it plentiful among the keys, but they never get me any specimens, although I offer a good price for them. It seems to be more or less plentiful at Key West. Here we get a straw-colored variety with one row of spots beneath, and a variety with three rows of spots beneath.

Clay (COPEIA, 1938: 180) gives another account of a straw-colored phase:

> The color pattern of this snake is extremely variable. Its most constant feature is a midventral row of light spots, one on each scute; posteriorly the series may become irregular or indistinct. The back usually has a series of about 30 dark, ill-defined cross-bars, each of which is so expanded and constricted at intervals as to tend to produce longitudinal stripes. The presence of two or four longitudinal stripes is not unusual, especially in the neck region. Some specimens are almost uniformly melanistic, while others are reddish or straw-colored and entirely without dorsal markings.

The writer has compared two living specimens of the reddish phase with color plates of the 1930 issue of the Maerz and Paul Dictionary of Color, Plate 6, line 12, and interprets the color as henna-red. The individual specimens vary somewhat in density of color.[1] The term "straw-colored" mentioned by Barbour and Noble and by Clay probably refers to this phase.

On February 19, 1939, two female *Natrix compressicauda* were collected on the east shore of Lacosta Island, a small island which is bordered by the Gulf of Mexico on one side and Pine Island Sound on the other, approximately 20 miles west of Fort Myers, Florida. Both of these specimens, as well as others (in this region *compressicauda* is exceedingly numerous), were collected in a nearby salt water mangrove swamp. Many specimens were noted swimming about in open water close to the shore. Color phases of adults observed from this locality indicate that there are more individuals of the uniformly henna-red color than there are of the banded form which are usually described as typical. Of a total of fifty-one specimens examined, twenty-nine were henna-red, twenty banded and two a black phase. The writer also collected eighteen *compressicauda* at Lower Matecumbe Key, Florida, in February, 1938; of these fifteen were banded and only three were henna-red.

Fortunately one of the breeding females to be discussed is henna-red and the other typically banded. On July 23, slightly over three months after capture, the henna-red female produced fourteen young; ten resembling the parent and four banded. Measurements of these young range from 140 mm. to 185 mm. Of the lot, one prematurely born specimen measured 95 mm. It is impossible to draw many conclusions regarding the relative size at birth of the banded and the henna-red because only two broods have been studied. However, it is interesting to note that the banded of this first brood measured from 183 mm. to 185 mm., whereas one of the henna-red measured 140 mm., another 166 mm., and the remaining eight measured from 179 mm. to 183 mm. One banded and two henna-red of this July 23 brood are living in a vivarium at the time of this writing, at the Peabody Museum Laboratories at Yale University.

On August 11, 1939, the banded female was preserved. Upon dissection she was found to be carrying five young. Judging by their appearance, they were within a few hours of birth. Four were banded and one showed a strong tendency toward the henna-red phase. Measurements of the banded are 200 mm., 210 mm., 215 mm., and 218 mm. The henna-red individual measured 187 mm. Barbour and Noble mention that one of Mr. Reynold's banded *compressicauda* gave birth to fifteen young, ten resembling the parent and five uniformly straw-colored. A study of the genetics of these very distinct color-phases of this snake would be highly interesting.

The foregoing observations on *Natrix compressicauda* were made while working at the Field Laboratory of the New York Aquarium located on Palmetto Key, Florida.—MARSHALL B. BISHOP, *Peabody Museum, Yale University, New Haven, Connecticut.*

[1] Henna, in the Maerz and Paul nomenclature approximates Morocco Red of Ridgeway.

THE RED SALAMANDER (*ENSATINA ESCHSCHOLTZII* GRAY) ON VANCOUVER ISLAND.—The red salamander is locally distributed in British Columbia in the lower Fraser Valley of the mainland in the southwestern part of the province, where it is commonly found in damp woods, particularly near logs in advanced stages of decay. Until the present time there has been some doubt as to the presence of this species on Vancouver Island, since the specimen upon which the only record was based (Hardy, G. A., Amphibia of British Columbia, Ann. Rept. Prov. Mus. Nat. Hist., 1926 (1925): C21–C24) has been lost. The occurrence of *Ensatina eschscholtzii* on Vancouver Island has been confirmed, however, by the finding of an adult specimen by Mr. G. C. Boyd, of Lake Cowichan, in a decaying cedar log near the lake shore on August 15, 1939.

This specimen measures as follows:

Snout to anus	58 mm.	Fore limb	18 mm.
Front of anus to end of tail	52	Hind limb	20
Width of head	11	Heel to end of longest toe	9
Snout to fore limb	19	Breadth of foot	4
Axilla to groin	31		

The specimen has been added to the collection of the Provincial Museum, Victoria, British Columbia.—G. CLIFFORD CARL, *Fisheries Research Board of Canada, Cowichan Lake Hatchery, British Columbia.*

EUMECES IN THE MIAMI AREA.—For many years it has seemed to the senior author that he never saw but one species of skink in the general region about Miami, Coconut Grove, and Cutler, in Dade County, Florida. In other parts of the state he should say that *Leiolepisma* appeared to be at least as common as *Eumeces* and in most places very much more abundant even though more than one member of the latter genus was to be found.

In 1939, beginning in February, Barbour determined to collect as many skinks as possible from the vicinity of Coconut Grove. The season was an extraordinarily dry one and lizards of all sorts were very scarce until the unusually late spring rains finally came. With the aid of Mr. H. F. Loomis, of the Staff of the Chapman Field Plant Introduction Garden, the word was passed about that a small reward was forthcoming for each skink secured. Loomis continued to preserve specimens after Barbour left for the north, until between us we had one hundred individuals. These are now before us and, as had been surmised, the series runs as uniform as one could possibly imagine. All the specimens are, generally speaking, and with the exception noted below, as alike as peas in a pod and all are unquestionably *Eumeces inexpectatus* Taylor. The head scales vary markedly. The best diagnostic character that Taylor gives seems to be the absence of broadened median sub-caudal scales, which holds consistently throughout the series except where the tail has been broken off and has regenerated. The Miami series shows no differences from specimens from near the type locality, which was Citrus County, Florida.

This species seems to be unquestionably distinct, little as the senior author was inclined to accept it when it was first described. Moreover, it seems to be the only one which has adapted itself to life under the rather specialized environmental conditions existing in its rocky and decidedly tropical habitat. It is one of the very few forms which have established themselves on some of the waterless and poorly vegetated islands on both coasts of the peninsula. *E. inexpectatus* is much less arboreal than either *laticeps* or *fasciatus*. Although it climbs trees when pressed, it is usually found on the ground among leaves or about fallen logs, and particularly about stone walls or old buildings made of cut rock.

One would have expected to find a certain number of individuals of *E. egregius* (Baird), but not a single one appeared in this collection nor have we ever seen one during the innumerable visits made to this part of Florida. Why this should be is difficult to understand inasmuch as conditions on the upper Florida Keys, where *egregius* is common, would not seem to be conspicuously different from those of the mainland, however much this strip of Dade County differs from all the rest of the Peninsula of Florida.—THOMAS BARBOUR, *Museum of Comparative Zoology, Cambridge, Massachusetts,* and A. F. CARR, JR., *University of Florida, Gainesville, Florida.*

HEMIDACTYLIUM SCUTATUM FROM NORTHERN DUTCHESS COUNTY, NEW YORK.—An adult female specimen of the four-toed salamander, *Hemidactylium scutatum* (Schlegel), measuring 31 mm. from tip of snout to the posterior insertion of the hind limbs, and 39 mm. from insertion of hind limbs to tip of tail (total length 70 mm.), was taken 2 miles southeast of the village of Red Hook in the town of Red Hook, Dutchess County, New York, October 1, 1939. The salamander was found beneath a medium-sized log in an area which is normally a small woods-fringed pond, but which, owing to the excessively dry summer of this year, is almost devoid of free water. The area is moist and swampy, however, and is abundantly overgrown with tall grasses, mosses and low shrubs. The presence of large moss-covered logs and stumps makes it highly probable that under normal conditions this pond and other similar ponds of the region are suitable breeding environments for *Hemidactylium*.

Associated with the four-toed salamander in the same pond bed were found the common eastern newt, *Triturus viridescens viridescens* (Rafinesque), in the red eft stage; an adult red-backed salamander, *Plethodon cinereus* (Green); and a juvenile eastern wood frog, *Rana sylvatica* Le Conte.—M. LELYN BRANIN, *Bard College, Columbia University, Annandale-on-Hudson, New York.*

EYE COLOR IN THE BOX TURTLE *(TERRAPENE CAROLINA)*.—In view of the question as to the value of eye color in the box turtle as a criterion of sex, I have compiled and arranged incidental notes made on the color of the eyes of such adult Long Island box turtles as could be satisfactorily classed as female or male, from having quite flat or dinstinctly concave plastrons.

In eighty-two female turtles with plastron length 4⅝ inches and upward, a prevailing eye color is buffy, buff, yellowish, straw yellow, or gilt, sometimes more or less mottled, and in exceptional cases dull orange and bright light yellow. Twenty-two individuals, or 27 per cent, fall in this category. Sometimes there is a dark center, usually purplish, and pale, buff or gilt outer margin; such being the case in six individuals, or 7 per cent—34 per cent for the two groups combined.

The eye is frequently prevailingly dark purple, purplish or purplish brown more or less mottled purplish and yellowish, sometimes combining to give a brownish effect. Ten individuals, or 12 per cent are so recorded. A prevailing eye color is brownish, brown, dark brown or red brown, sometimes mottled, in an exceptional case mottled rufous. Nineteen individuals, or 23 per cent fall in this category—35 per cent for the two groups combined.

The strikingly bright salmon-red, or pink eye characteristic of males seems not to occur in female turtles, but I am surprised to find my records show so many females with eyes varying from dull reddish and dark brownish red to brick red and bright dark red, in exceptional cases mixed yellowish and wine red, and dark red and grayish. Twenty-two individuals or 27 per cent fall in this category. Two had a dull pink and one a mottled old rose eye, the three, 4 per cent of the total—and added to the "red" group making 31 per cent.

There are eye color notes on only three turtles of under 5 inches plastron length (4¾ and 4⅞) with plastron sufficiently concave to be definitely males. The eye color was brown to dark brown.

One hundred and ten male turtles with plastron 5 inches long and upward almost all have red or pink eyes—red, bright red, salmon red, light red, pink, pink and white, to almost or quite white, in exceptional cases reddish, dull rose red, dull pink and bright scarlet. One hundred and six and one-half individuals go in this category, or 97 per cent of the total. The color of their eyes is usually distinguishably brighter, clearer, or paler than the red eyes of females. The remaining 3 per cent is made up of one individual with orange-reddish, one with yellowish, one with yellow eyes, and a fourth in which the plastron was 5½ inches with one eye brown, the other salmon red.

The highest percentage of pink, pink and white, and white eyes occurs in turtles of 5½ to 5⅝ inch plastron (41½ per cent in this size group); in larger individuals of 5¾ to 6¼ inches it is less (23½ per cent), in smaller individuals of 5⅛ to 5⅜ inches still less (15 per cent), and none of the six turtles that make up my 5-inch group has such eyes.—J. T. NICHOLS, *New York City, New York.*

NOTES ON THE FOOD HABITS OF THE COMMON SNAPPING TURTLE.—The following information on the food of the snapping turtle, *Chelydra serpentina* (Linnaeus), is based on the stomach analyses of eighteen specimens collected in New York and Massachusetts; approximately thirty hours of field observation between April 23 and June 6, 1939, at Dryden Lake, Tompkins County, New York; and observations on a small specimen kept in captivity indoors for a year.

TABULATION OF FOOD ITEMS FOUND IN EIGHTEEN SPECIMENS

	Percentage by frequency	Percentage by bulk
Plant material	61.05	52.9
Filamentous algae	11.11	11.0
Pondweeds and similar plants	22.20	13.2
White water-lily leaves (*Nymphaea odorata*)	11.10	8.33
Duckweed (*Lemna* spp.)	16.65	11.0
Unknown plant material	16.65	6.5
Animal material	77.78	39.26
Molluscs (snails and clams)	22.20	0.34
Crustacea (crayfish)	27.75	25.44
Insects (aquatic beetles)	16.65	0.30
Fish (listed below)	27.75	7.33
Common sunfish (*Eupomotis gibbosus*)	11.10	2.12
Yellow perch (*Perca flavescens*)	5.55	1.87
Common sucker (*Catostomus commersonnii*)	5.55	1.87
Bass sp.	5.55	0.25
Frogs	5.55	0.05
Turtles (?)	5.55	0.05
Birds (feathers with aftershaft present)	5.55	0.16
Unknown animal material	11.10	5.00
Unknown whether plant or animal	16.65	7.7
Mineral material	5.55	0.11

The proportions of food items found do not clearly indicate the actual proportions consumed. Plant material remained in the alimentary canal for a long while without losing much of its bulk, while animal flesh was quickly digested and absorbed. One large animal contained the remains of three good sized fish in the stomach, but the bulk represented here was very small since all that remained was a little skin and some bones.

Availability seemed to play a great part in determining the nature of the food. Considerable variation was found according to the environment in which the animal was taken. In ten specimens taken from marshy lakes, I find the following percentages of plant and animal food:

	Percentage by frequency	Percentage by bulk
Plant	90	80.28
Animal	60	16.52

In three small turtles taken from pebbly streams, crayfish made up 100 percent of the food.

It is not known whether the fish listed as food items were taken alive or as carrion. There is evidence to support the latter assumption. A live specimen kept in captivity showed preference for dead fish over live ones.—S. MORRIS PELL, *Department of Zoology, Cornell University, Ithaca, New York.*

A NOTE ON THE FOOD OF THE BOX TURTLE.—On June 7, 1939, the writer, while engaged in work along the Hudson River in Banks County, Georgia, saw a box turtle (*Terrapene carolina*) eating a mushroom. The turtle had so gorged itself with the fleshy fungus that it was unable to close the plaston without emitting some of the plant.

Since specific identifications of foods of this turtle are generally lacking, the mushroom was collected and sent to the U. S. Department of Agriculture in Washington, D. C. There, the Bureau of Plant Industry identified it as *Amanitopsis vaginata*, a nontoxic species.

It would now appear that experiments are in order to determine whether these turtles can distinguish between toxic and nontoxic mushrooms.—EDWIN P. CREASER, *U. S. Biological Survey, Atlanta, Georgia.*

A NOTE ON REPTILIAN SEX RATIOS.—In the course of several experiments with young alligators, aged 19 months or less, the author was struck with the fact that autopsy showed the majority of the animals to be females. Of a total of 266 alligators, 55 were males and 111 were females, a ratio of 1:2. These animals had been purchased from a dealer without specifications as to sex, which in alligators as young as these can only be determined by a careful examination of the cloacal region. The dealer, who is believed competent to determine the sex of young alligators, was asked if he could give any data on the sex ratio of this reptile. He volunteered the information that on a recent hunting trip he had found one nest of alligators aged one year and five months, and two nests of alligators aged only five months. Of the 11 older animals, 6 were females and 5 were males; and of the 41 younger animals, 30 were females and 11 were males.

While the above data are necessarily limited, it is believed that they are of sufficient significance to be worthy of record. It is apparent that the most reliable way to gather figures on reptilian sex ratios would be to examine large numbers of embryos or newly hatched or born young. It has been pointed out many times that a selective mortality of the embryos as well as sexual differences in ease of capture, resistance to disease, and other factors operating after hatching or birth may mask the true sex ratio of animals taken in the field. In addition, the sex ratio of a species or group cannot be determined accurately on the basis of a small number of specimens.

A careful survey of the literature revealed only a few valid reports on reptilian sex ratios; the numerous references cited by Pelseneer (1926, Acad. Roy. Belgique, Mem. 8: 1–258) were checked by the writer and were judged to be of little or no significance as regards this point.

Two reports on the sex ratios of snakes should be mentioned. Blanchard (COPEIA, 1937: 151), collecting *Storeria occipitomaculata,* found 16 male and 9 female immature and 28 male and 33 female new-born animals and concludes that in this snake the sex ratio is practically 1:1. Klauber (1936, Occ. Pap. San Diego Soc. Nat. Hist., 1: 2), in an extensive study of *Crotalus* and *Sistrurus,* found that of 453 rattlesnakes examined at or about the time of birth, 213 were males and 240 were females. Hence, on the basis of available data, it would appear that snakes do not show an unusual deviation from the 1:1 sex ratio.

This does not seem to be the case in those representatives of the Testudinata that have been studied. Hildebrand (1933, Journ. Hered., 24: 241), reporting on *Malaclemmys centrata,* states that of a total of 1,433 terrapins which were old enough to show external sexual dimorphism, 200 were males and 1,233 were females, a ratio of 1 male to 5.9 females. Hildebrand indicates (1932, Zoologica, 9: 551) that the unequal sex ratio cannot be ascribed to post-hatching mortality among the males; there remains the possibility of pre-hatching differential mortality. Risley (1933, Pap. Mich. Acad. Sci., 17: 685) has reported that, of 255 adult *Sternotherus odoratus* taken in the field, 77 were males and 178 were females, a ratio of 1:2.3. Of the 161 of these animals taken after the breeding season, 61 were males and 100 were females (1:1.6). The observations on a preponderance of females over males in turtles are in agreement with those here reported for *Alligator.*

No satisfactory reports on the sex ratios of the lizards, crocodilians, or *Sphenodon* could be found in the literature.

It is apparent that the data thus far available on reptilian sex ratios are still very incomplete. It is to be hoped that further careful observations will be made in the field and the laboratory so that the apparent marked inequality in the sex ratios of some reptiles may be dispelled or confirmed. It may be that the distribution of the sexes in reptiles will be shown uniformly to approach the usual 1:1 ratio; if not, a most interesting problem will await further analysis.—THOMAS R. FORBES, *Department of Anatomy, Johns Hopkins Medical School, Baltimore, Maryland.*

ADDITIONS TO THE HERPETOFAUNA OF NORTHEASTERN KENTUCKY.—Since the paper *Amphibians and Reptiles of Northeastern Kentucky* by Wilfred A. Welter and Katherine Carr (1939, COPEIA: 128–130) went to press two additions have been made to the herpetofauna of this region. *Plethodon richmondi,* recently described by Netting and Mittleman (1938, Ann. Carnegie Mus., 27: 287–293), has been found to be as common as *P. cinereus* in Rowan and Carter counties. Another species was added during the summer of 1939 when the green salamander, *Aneides aeneus,* was taken at several

stations. The first specimen was secured by the junior author and Mrs. Bernice Lewis Barbour in a rotten basswood stump standing in a rhododendron thicket near Pine Ridge in Menifee County. Further search failed to reveal additional specimens. On August 3, 1939, Ida Pearl Sparks and Thelma Fraley, students at Morehead State Teachers College, secured three specimens of *Aneides* from beneath the bark of a fallen butternut tree in the rock cliff area of Rowan County, near the head of Christy Creek. An additional specimen was taken a few days later by the senior author in Elliot County along the Little Sandy River near Ordinary. This specimen was taken from beneath the bark of a black gum tree. The finding of these specimens of *Aneides* has extended the range of this species in Kentucky from Pine Mountain, Harlan County, in the southeastern part of the state, to Rowan County, in the northeastern part of the state, a distance of nearly 200 miles.—WILFRED A. WELTER and ROGER W. BARBOUR, *State Teachers College, Morehead, Kentucky.*

PSEUDOTRITON MONTANUS MONTANUS IN WEST VIRGINIA.—Apparently the only record of *Pseudotriton montanus montanus* (Baird) in West Virginia is that of Netting, who, in his list of 1933 (West Virginia Wildlife, 11 (3–4): 6), gives Mercer County as the one locality for this animal. There is a specimen in the Cornell University Museum (No. 3087), taken July 1, 1931, at Sandy Creek, Jackson County, by the senior author. This is the only specimen of *P. m. montanus* taken during the summer of 1931, by the Travelling Summer School of the University of West Virginia, under the leadership of Dr. P. D. Strausbaugh. There are also specimens of *P. ruber ruber* from various other West Virginia localities in the Cornell collection. This record, from the lowlands of the Ohio River drainage of the western part of the state, indicates again that *P. m. montanus* is not confined to the mountains as one might suppose from its name.—A. H. WRIGHT and HAROLD TRAPIDO, *Laboratory of Zoology, Cornell University, Ithaca, New York.*

A NOTE ON THE EGGS OF *PLETHODON GLUTINOSUS*.—Not until comparatively recently was anything known about the eggs and larvae of one of our common salamanders, *Plethodon glutinosus*. Noble and Marshall (1929, Amer. Mus. Nov., 347: 1–12) published the first definite description of these eggs and larvae from material collected by them in Arkansas caves. Prior to this report, Okey (1916, Ohio Journ. Sci., 17: 25–50, 5 pls.) reported embryos taken from four lots of eggs, supposedly of this species. Noble and Marshall subsequently invalidated this report by showing that Okey was probably describing larvae of *Ambystoma texanum*. These authors bring up questions as to the egg laying of *P. glutinosus* in areas without caves and from the fact that young *glutinosus* are often found in and around rocky springs, they postulate that adult *P. glutinosus* penetrate the ground for some distance to lay their eggs, and suppose that the young, upon hatching, follow the crevices formed by ground water and emerge at such springs.

On June 3, 1938, while collecting on Ice Mountain, Hampshire County, West Virginia, a female *P. glutinosus* with eggs was taken on a wooded hillside in a valley at the foot of the mountain. It was found inside of a rotting stump when the stump was torn apart, coiled with a bunch of about fifteen eggs. Although there are caves in the region from which this specimen was secured, the species is more often found in situations similar to that above described. This seems to indicate that the site chosen for egg laying by the specimen in question is representative for the species in this area, and hence for regions with or without caves.

That these eggs should have been collected in June, while those collected by Noble and Marshall were found in August and September, seems to be what might be expected on the basis of our knowledge of *Plethodon cinereus*. Eggs of the latter species have been reported as early as June and as late as October (Dunn, 1926, The salamanders of the family Plethodontidae: 167–168), and there is no reason to believe that *P. glutinosus* could not also have such an extended breeding season.—J. A. FOWLER, *Department of Zoology, George Washington University, Washington, D.C.*

MARKING OF FROGS FOR FUTURE REFERENCE IN NATURAL HISTORY STUDIES.—In a study of the life-history of the bullfrog, *Rana catesbeiana,* a method of marking frogs for release and later capture was needed in connection with studies of growth-rate and wandering. Use of the system described below was begun in October, 1934, at Ann Arbor, Michigan, and continued at Baton Rouge, Louisiana, from October, 1935, until July, 1937; during the latter period more than 200 frogs were marked. Hamilton (COPEIA, 1934: 88–90) marked 20 toads "by incising one or more toes on the fore feet"; the present system was elaborated independently of this suggestion.

The digits of the four feet are numbered consecutively from 1 through 18, beginning at the left of the left fore foot and ending at the right of the right hind foot. By cutting off two or three phalanges of not more than three digits in various combinations, 987 frogs can be individually marked. One digit off all the way around marks the first 18 frogs. The next series begins with digits 1 and 2 off, 1 and 3 off, etc., through 17 and 18 off. This will mark 153 frogs. The last series begins with digits 1, 2, and 3 off; 1, 2, and 4 off, etc., through 1, 2, and 18 off; then comes back to 2, 3, and 4 off; 2, 3, and 5 off, etc., until the last one of the group which is 16, 17, and 18 off. This series of combinations will mark 816 frogs.

Healing occurs in a very short time and the frogs do not appear to be handicapped by the loss of the digits. The digits do not regenerate the lost parts, so that we thus have a permanent, inconspicuous, individual marking system for frogs.—IRA D. GEORGE, *Louisiana State University, Baton Rouge, Louisiana.*

A LEARNING EXPERIMENT WITH SNAKES.—In the summer of 1936 a series of learning experiments with snakes was conducted at the University of Mississippi, using eleven *Natrix rhombifera rhombifera* (Hallowell). A multiple-T maze with two choice-points, and sliding doors to prevent retracing, was used. In the only other experiment of this type (Kellogg and Pomeroy, 1936, Journ. Comp. Psychol. 21: 275–295) escape from cold water was used as motivation. Believing that a snake would become progressively more sluggish the longer it remained in cold water, we used heat. At first the maze was assembled in an outhouse having concrete floor and walls, but no roof. The snakes were run when the floor was in direct sunlight and had been so for several hours. The floor temperature ranged between 48° and 55°C; the temperature of the shaded pan of water used as a goal ranged between 27° and 35°C. Each snake was run once each day. A series of cloudy and comparatively cool days forced the abandonment of the outdoor maze, however, and an indoor one of the same pattern, using about half an inch of sand on a tin bottom and heated from beneath by electric light bulbs, was constructed. After several days with this maze we focused an electric heater from above on the starting point in an attempt to make the snakes start sooner. After a week of daily trials we tried giving the same snake 10 trials each day. A few errorless runs were recorded, but under none of the three conditions did any snake show evidence of learning the pathway. The grand total shows only 27 errorless runs out of 179.

Finally an attempt was made to condition an escape response from an electric shock. The snake was put into a two-compartment box with a connecting doorway. The floor of each compartment could be charged. It was thought that the snake might learn to escape to the uncharged compartment when it was shocked. However, it was impossible to standardize the response; the amount of shock required to start a snake varied greatly from trial to trial, and frequently the snakes would blunder their way out of the charged compartment after some time, and then immediately return to it.

While none of these experiments gave any significant data on snake learning, they do offer some suggestions regarding motivation. With the outdoor maze in direct sunlight the snakes started soon after being introduced, and almost always succeeded in finishing. In only three of a total of 77 runs was a snake overcome by heat before completing the maze. In contrast, the snake did not seem to understand the artificial heat of the indoor maze, and frequently remained at the starting point until almost overcome. In 102 runs, snakes were removed from the maze 22 times. Further, the average run on the indoor maze required approximately twice as long as the average for the outdoor maze.

It is suggested that direct radiant heat, such as hot sunlight, be used for motivation in possible future experiments on snake learning.—DAEL L. WOLFLE, *University of Chicago, Chicago, Illinois,* and CALVIN S. BROWN, JR., *University of Georgia, Athens, Georgia.*

FOOD OF AN EASTERN ROCK RATTLESNAKE IN CAPTIVITY.—Two eastern rock rattlesnakes *(Crotalus lepidus lepidus* Kennicott) from western Texas, collected in the vicinity of the McDonald Observatory, Davis Mountains, Jeff Davis County, by Dr. and Mrs. Paul Rudnick during the summer of 1938, were presented to Field Museum by Mrs. Rudnick in September of that year. The specimens were in excellent condition; one was used by Mr. Leon L. Walters for a mold from which an exhibition model was subsequently prepared. The other specimen, a female, was kept alive for Mr. Walter's use in coloring the model, and was placed in my charge.

The specimen was kept in a large terrarium, heated by means of an electric light bulb placed inside of a one pound size bread pan. The bread pan was then buried in the sand to a depth of 2 to 3 inches below the sand surface. This gave a very satisfactory source of heat that tested 84° Fahrenheit on the surface of the sand directly over the unit. This method of supplying heat in a terrarium has been used for other laboratory animals at the Field Museum and Chicago Academy of Sciences.

Throughout the duration of captivity (one year and two months) the specimen remained exceedingly alert. When food was offered, the snake would immediately show interest and move in the direction of its prey. This happened in all feedings, including instances of refusal.

The records were kept from September 23, 1938, until November 6, 1939. During this period of captivity the following animals were consumed. Three tiger salamanders *(Ambystoma tigrinum),* one cricket frog *(Acris crepitans),* three swamp tree frogs (*Pseudacris triseriata*), one leopard frog (*Rana pipiens*), one wood frog (*Rana sylvatica cantabrigensis*), three white-footed mice (*peromyscus* sp.), twenty-one house mice (*Mus musculus*), and three voles (*Microtus* sp.).

The interval between feedings averaged thirteen days. The shortest interval between feedings was one day while the longest was forty-seven days. During the forty-seven day interval three house mice were killed but not eaten and one leopard frog was refused unharmed.

On two occasions the common aquarium newt (*Triturus viridescens symmetrica*) was offered as food. On the first the specimen was seized and killed but not eaten. The second specimen was offered four months later. It also was promptly seized but was released unharmed.

When amphibians were taken, the snake deliberately grasped the food animal, retained it in its jaws, and by means of chewing motions imbedded the fangs as deeply as possible. The procedure was very different in taking mammals. Mice were invariably not retained in the mouth, death occurring rapidly. The snake eagerly followed its dying prey, which only occasionally reached even the opposite side of the cage before collapsing. The action of the venom was clearly more rapid on mice than on frogs and salamanders.

The skin was shed seven times, the interval between sheddings varying from twenty-two to ninety-five days. The snake grew from a length of 407 mm. at the beginning of the record to 476 mm. at the time it was preserved.—E. GUSTAV J. FALCK, *Chicago, Illinois.*

XANTUSIA VIGILIS IN UTAH AND NEVADA.—What appears to be the first specimen of *Xantusia vigilis* Baird from Utah was taken by the writer in Washington County on September 10, 1939. The lizard (Stanford Natural History Museum Reptile Cat. No. 8158) was found beneath the dead limb of a Joshua tree, just north of U. S. Highway 91, near Castle Cliff, Utah.

Klauber (COPEIA, 1932: 123) mentions *X. vigilis* from the Pahrump Valley and records specimens from five miles north of Jean and from the Piute Valley in Clark County, Nevada; Cowles and Bogert (1936, Herpetologica, 1: 39) record specimens from near Kyle Canyon, eastern base of Charleston Mountain, and from ten miles west of Jean in Clark County, Nevada. On September 11, 1939, another specimen of *X. vigilis* (S. N. H. M. No. 8159) was secured in Clark County, Nevada, just east of Nevada State Highway 5, twenty miles northwest of Las Vegas, under the dead limb of a Joshua tree. —MARGARET STOREY, *Natural History Museum, Stanford University, California.*

THE WESTERN RING-NECKED SNAKE IN IDAHO.—The United States Bureau of Biological Survey recently received from Messrs. William H. Marshall and George Holman a half-grown western ring-necked snake (*Diadophis amabilis occidentalis*) that had been collected by Mr. Joe Webster, in November, 1937, about five miles southwest of Horseshoe Bend, in Boise County, Idaho, at an elevation of about 2,500 feet. This specimen (U. S. B. S. No. H. 8859) appears to be the first record of this genus from that state. Its ventral surface is somewhat more heavily marked with narrow black spots than is typical for this subspecies.

So far as the writer is aware, there are no records of the occurrence of the western ring-necked snake nearer to Horseshoe Bend, Idaho, than those reported by Dr. Arthur Svihla from Whitman County, Washington (COPEIA, 1933: 125; and 1938: 47). It seems probable that specimens will eventually be taken at intermediate points along the Snake River.—F. M. UHLER, *U. S. Bureau of Biological Survey, Washington, D. C.*

AN EXTENSION OF THE RANGE OF *BUFO CANORUS* CAMP.—On September 18, 1939, Dr. Osgood R. Smith, of the U. S. Bureau of Fisheries, and the writer collected two specimens of *Bufo canorus* Camp on the west branch of the McGee Creek trail, Mono County, California (118° 50′ N. Lat., 37° 30′ W. Long.), at an elevation of 10,500 feet. This locality is about 38 miles southeast of Tioga Lake, Mono County, California, which I believe was hitherto the most southeasterly reported station for the species. These specimens have been catalogued in the Stanford Natural History Museum as: No. A4358, a female with a head and body length of 29.5 mm.; and No. A4359, a male with a head and body length of 48.2 mm. The locality was sparsely wooded, though there was considerable underbrush and lush ground-covering. The toads were taken on the trail, which is approximately 300–400 feet up the west slope from the creek. Many calls from a nearby meadow were heard which were assumed to be those of the Yosemite toad, though a cursory examination of the meadow did not reveal any toads. The mean daily temperature at the U. S. Bureau of Fisheries Convict Creek Experimental Station, which is in the next valley about eight miles north of the above locality, was 60.1°F. for the time between September 1 and 20, 1939. The extreme temperatures were 34.0°F. and 74.5°F. However the Experimental Station is at an elevation of only 7,500 feet. Some snow had fallen in the locality of collection during the week preceding the eighteenth of September. By this time, in 1938, the ground squirrels had already dug in for the winter, although they were numerous during all of September, 1939. It was noticed that the warts of both the female and the male were a rich russet colour, and that the male was much more mottled during life than in alcohol. Two small specimens of *Hyla regilla* were collected at the same time and place.—KENNETH STANTON, *Natural History Museum, Stanford University, California.*

HYPSIGLENA OCHRORHYNCHUS IN OKLAHOMA.[1]—Four specimens of the interesting snake *Hypsiglena ochrorhynchus* Cope were recently found in Oklahoma, and so far as known form the first records of this species from the state. The first two specimens were taken on April 23, 1938, one by the author (UOMZ No. 22007) the other by Miss Edith R. Force (Chicago Acad. Sci. No. 4674). They were found in Comanche County, three and one-half miles north of Cache, near Crater Creek. The other two specimens were collected on June 14, 1938, five miles northwest of Cache. Three of the four specimens were found under granite boulders on the western slopes of the small stream valleys. The scale counts are as follows: (UOMZ 22007, UOMZ 22060, UOMZ 22061, and Chicago Acad. Sci. 4674) scale rows, 21-21-17, 21-23-17, 21-21-17, 21-21-17; ventrals, 173, 169, 170, 175; caudals, 42, 52, 52, 38; supralabials, all 8–8; infralabials, all 10–10; preoculars, 2-2, 2-2, 2-2, 1–1; postoculars, 2–2, 1–2, 2–2, 2–2; temporals, all 1 + 2; total length, 165, 335, 314, 154 mm.; tail length, 22, 60, 55, 21 mm.

The scale counts of the specimens in the Chicago Academy of Sciences were kindly furnished by Dr. H. K. Gloyd.—ROBERT E. KUNTZ, *Museum of Zoology, University of Oklahoma, Norman, Oklahoma.*

[1] Contribution from the Zoology Department, University of Oklahoma, No. 212.

Ichthyological Notes

THE EXPULSION OF YOUNG BY THE MALE OF *HIPPOCAMPUS ZOSTERAE*.—A male *Hippocampus zosterae* Jordan and Gilbert, kept in an aquarium at the research laboratory of the New York Aquarium on Palmetto Key, Florida, was noted to have its brood pouch distended with young. These could be seen to move from time to time through the thin membranous pouch wall. Since evidently the expulsion of the young was imminent, a fairly close watch was kept of the fish. As a result the complete procedure took place under observation. This occurred at noon on February 9, 1939.

Shortly before the discharge of the young began the pouch became nearly spherical in shape and so great was its distention that it appeared as though it would burst. What muscular arrangement permits of this distension is not clear but it is evidently not due alone to the increasing size of the young, for despite their relatively large size they were able to move about within the walls of their enclosure with comparative ease.

The whole "parturition" occupied about ten minutes amid labor-like contortions of the male. For most part this partook of a forward bending into a position of cramp followed by a rapid backward bend with an ejaculatory movement. This snapping back distended the brood pouch to such an extent that its orifice became practically circular in outline. When "births" occurred, it was always immediately after such a movement. The young fish generally left the pouch with explosive violence accompanied by a flow of fine fragments (egg shell, etc.?) as the pouch slightly contracted. At intervals the male seemed exhausted and drooped quiescently to an almost horizontal position. Each of these positions is shown in Figure 1. After the last young seahorse was expelled, the sac returned to nearly normal proportions in about three minutes, and within an hour had completely subsided. During the entire procedure the male retained a firm hold on a bit of seaweed and at no time shifted his position. There was no attempt to rub the abdomen on objects as an aid to expelling the young as has been described from some of the larger species.

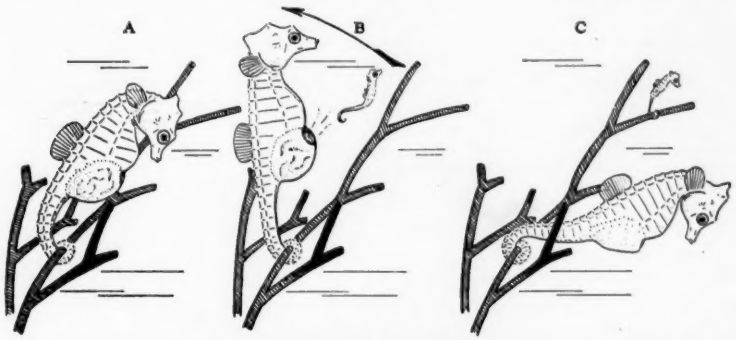

Fig. 1. Expulsion of young by *Hippocampus zosterae*.

A. The arched-over position which is assumed slowly. B. The erect posture during which the pouch is greatly expanded and the young expelled. C. Final resting posture with pouch returning to a flaccid condition after last one has been expelled.

At the start of procedures the tail of one emerged during one of the contortions of the male. This was later drawn back while simultaneously the head of another appeared which actually was destined to be that of the first born. This emerged head first, as did most of the others, although one came tail first and another folded in about the middle as in a breach presentation.

In all eight were born. The first swam to a nearby bit of seaweed and clung in a typical upright position while the parent labored on to bring forth the rest of the brood. The parent measured 33 mm. in length and the young averaged about 8.5 mm. and al-

though more slender in form, deported themselves very like their parent. The relative sizes may be noted in the accompanying figure, which has been carefully drawn to scale.

Another male, not studied in detail, of about the same size gave "birth" to six young of similar proportions. These were preserved at the time by M. B. Bishop during the same month. Due to the extremely small adult size of this species, and the particular reproductive mode of these fishes, it is essential that if the eggs and young are to retain their typical size they must be correspondingly few in number. Actually the young are not far from the size of those of *Hippocampus hudsonius* DeKay, which counts its broods in the hundreds.—C. M. Breder, Jr., *New York Aquarium, New York City.*

THE SPAWNING OF *MUGIL CEPHALUS* ON THE FLORIDA WEST COAST.—On the basis of the state of the gonads of mullet, *Mugil cephalus* Linnaeus, caught for market on the west coast of Florida, it is evident that spawning takes place principally in December, January and February in the vicinity of Boca Grande. Very small specimens, scarcely recognizable as mullet, as well as specimens in the *Querimana* stage are abundant about the mangrove stands in the last mentioned month and later.

Questions directed to the local fishermen elicited the information that spawning occurred in small tidal flows on the larger islands. Following this lead a visit was undertaken to Flat Creek on La Costa Island on February 11, 1939. This body of water is very narrow at its mouth and winds for about half a mile through a dense grove of mangrove trees which meet overhead. At this distance inland it widens out to a flat shallow area that is floored for most part with clean hard sand.

Here large mullet were to be seen in great numbers. They were variously scattered about in small groups, and with care could be approached closely by wading cautiously. It was evident that spawning was in progress. The males, which averaged about two-thirds the size of the females, could easily be recognized by a distinct pearly sheen overlying their lengthwise striping, which sheen the females lacked. These differences in size and color were subsequently checked by internal examination of a considerable number of fishes from this place and from nearby areas. The groups were generally made up of one large female and a varied number of the smaller and more active males. When they became alarmed, several adjacent groups would merge into a single school and move off with remarkable speed. One aggregation which was observed in considerable detail was composed of five fish, a female and four males. These arrayed themselves as shown in Figure 1, the fourth male which huddled below the large female being completely hidden in a full dorsal view. These were large sized mullet, the female being

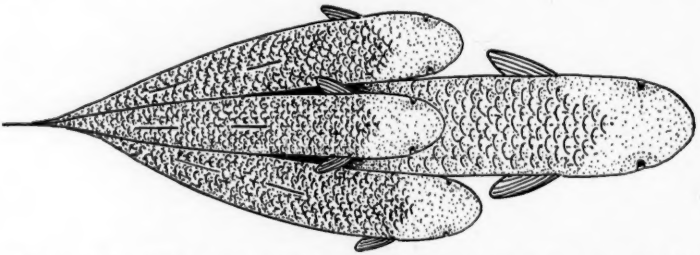

Fig. 1. *Mugil cephalus* in spawning attitude. Four males attend this large female, one being hidden from view below her. (Semi-diagrammatic.)

nearly two feet in total length and the males proportionally smaller. The males would press against the female as shown and from time to time visibly quiver. This took place as the entire troupe moved along slowly, facing into a fairly strong tidal flow. The unanimity with which the group moved made them appear as though fastened together. Although it seemed that spawning actually took place, no eggs could be recovered, but under the conditions this is not surprising. An attempt was made to photograph this and other groups, but because of the low visual angle, due to wading in water nearly knee deep and the lack of banks to climb because of the heavy mangrove stands flanking the area, this proved to be impracticable.

These fish, fat and firm before spawning, when in a spent condition are thin and flabby. Several in this place, taken by cast net, which had already spawned, in addition had suppurating sores on their bodies, seemingly from the effects of their reproductive activities.

According to Hildebrand and Schroeder (1927, Bull. U. S. Bur. Fish, 63 (1): 1–366, pp. 192–197) the chief spawning time extends from the middle of December to the end of January with some spawning in February in the region of Marco. This locality is some fifty miles south of our area and the agreement in time is complete. According to these students, fishermen at St. Petersburg state that mullet spawn off the passes along the outside beaches in about 24 feet of water on a rocky bottom. Here they congregate in vast numbers and the spawn may actually be seen in the water according to Capt. J. L. Sweat. He and others agree that they always spawn on the outside and never in bays, rivers or inlets. The present observations certainly do not lend these remarks support, but it may well be that both places are used, although our fishermens' remarks coincided with the present findings. It is also possible that the offshore observations refer to *Mugil curema* Cuvier and Valenciennes.

The present observations were made incidental to work on the life history of the tarpon undertaken at the research station of the New York Aquarium located on Palmetto Key. The author is grateful to Mr. M. B. Bishop of Peabody Museum, Yale University, and to Mr. B. Powell, caretaker of Palmetto Key, for valuable help on this field trip.—C. M. Breder, Jr., *New York Aquarium, New York City.*

NOTES ON NEW ENGLAND FISHES.—*Carcharodon carcharias* (Linnaeus).—One shark of this species was harpooned by Mr. J. W. Lowes, of Harvard University, five miles southwest of Wood End at Provincetown on August 24, 1939. The fish was 7 feet, 9 inches long and 4 feet, 9 inches in girth and had in its stomach about a dozen small spiny dogfish (*Squalus acanthias*). Mr. Lowes remarks that the latter is apparently a favorite diet for this shark (in New England waters) as it is the only food he has found in them. He states further: "On the same day shortly before we got this one I barely failed to iron another large shark which I feel sure was a white shark. Also, about ten days previous to this I ironed and lost a smaller white shark about five miles east of Manomet, Cape Cod. There is no question in my mind about this identification since the shark turned and bit at the iron when it was struck and I could see its teeth quite clearly."

Thus at least one if not several white sharks, or so-called man-eating sharks, were seen or caught off Cape Cod by one person the summer of 1939, indicating that more, perhaps many more, of this dangerous species visited New England waters during this past season. This is especially interesting because up until 1937, when six were caught, scarcely a dozen authentic records could be found for our northern waters. (Copeia, I, 1938: 46; I, 1939: 48.)

Prionace glauca (Linnaeus).—The blue shark, once thought to be rather rare in the Gulf of Maine, is now known to be one of the most common species. Mr. Lowes states that he has harpooned twenty-three in Massachusetts and Cape Cod Bays during the past few years. All of these fish were males.

Elops saurus (Linnaeus).—Found in the collection of the Museum of Comparative Zoology is a 14-inch specimen taken at Chatham, Cape Cod, October 19, 1888. This is the first definite record for the Gulf of Maine.

Fundulus majalis (Walbaum).—This species, formerly rare in the Gulf of Maine (Copeia, 4, 1937), now seems to be well established in parts of Cape Cod Bay, very likely because of the recent widening and dredging of Cape Cod Canal. Mr. J. W. Lowes reports that many specimens were observed in the vicinity of Cohasset the summer of 1939.

Hemirhamphus brasiliensis (Linnaeus).—The first New England record in recent years of this southern species is a specimen about 10 inches long caught in a fish weir in Chatham South Bay, Chatham, Mass., August 9, 1939. Mr. George I. Crowell obtained the fish and sent it to Dr. Richard Dow for the collection of the New England Museum of Natural History in Boston. A previous northern record was of a 5¾ inch fish taken in Buzzards Bay off Woods Hole, Mass., in August, 1898.—Henry B. Bigelow and William C. Schroeder, *Museum of Comparative Zoology, Cambridge, Massachusetts.*

THE BLANQUILLO (*CAULOLATILUS MICROPS*) AGAIN REPORTED OFF THE SOUTH CAROLINA COAST.—Almost seven years ago to the day (1932) I secured what is apparently the first specimen ever to have been taken off this coast, which was noted by Firth in COPEIA (3, Nov. 19, 1937). On May 5, 1939, while watching the smack "Harold" unloading its catch taken off the Grouper Bank I was surprised to see three specimens of what appeared to be *Caulolatilus microps*. On taking one to the Museum, I found after examination its characters check quite well with the description given in Jordan and Evermann (III: 2277). This specimen had a total length of 27 inches. Another was about the same size, the third was slightly larger.

These fish are known to the fishermen as southern tile fish or sand fish and were taken in 33 fathoms of water S.S.E. of Charleston, along with several specimens of *Garrupa nigrita, Epinephelus drummond-hayi, E. morio, Lutianus blackfordi, Rhomboplites aurorubens* and *Calamus leucosteus, E. drummond-hayi* being the most common of the groupers.—E. MILBY BURTON, *The Charleston Museum, Charleston, South Carolina.*

APRIONODON ISODON FROM SOUTH CAROLINA.—While fishing in the surf off the north end of Morris Island at the mouth of Charleston Harbor on October 8, 1939, I caught a young male shark 747 mm. in total length. Failing to identify it satisfactorily, I sent it to Stewart Springer at the Bass Biological Laboratory, who very kindly identified it for me, as being a specimen of *Aprionodon isodon* (Müller and Henle). Apparently this is the first record from South Carolina waters.—E. MILBY BURTON, *Charleston Museum, Charleston, South Carolina.*

THE OCCURRENCE OF "FREE-LIVING" *LIGULA* IN CATLIN LAKE, CENTRAL ADIRONDACKS.[1]—While mapping the gross vegetation in the shallow water of Catlin Lake on the Huntington Wildlife Forest Experiment Station, central Adirondacks, during the summer of 1939, I found several fully relaxed but perfect specimens of *Ligula intestinalis* in quiet water along the east shore. Although the larva of this parasite is common in the region and particularly in the common shiner (*Notropis cornutus*) and in the common sucker (*Catostomus commersonnii*), heretofore it has never been found outside the body cavity of the host. In fact there appear to be no published records of its occurrence anywhere in the "free-living" state in water.

My attention was first attracted to this unusual incident on July 29 when two specimens measuring, respectively, 12 and 14 inches in length, were observed partially suspended in about a foot of water over sandy bottom at the mouth of Deer Brook. A few days later three additional specimens were observed in the same locality and others were found at various points along the east shore. Undoubtedly, more records could have been obtained had a systematic effort been made for that purpose.

The question arises as regards the method of escape from the host. There appear to be at least two possibilities, namely:—1. The body wall of the host ruptures when the parasite becomes too bulky. 2. Predatory animals eat the host but in some instances leave the parasite. The second theory is strengthened somewhat by the fact that a single *Ligula* was found on top of a low projecting boulder where it had obviously been left by a predator.

It is not unusual to find more than one *Ligula* in a fish as small as the common shiner. The presence of even one larva is evident from the distended belly of the host. Additional numbers stretch the belly to an enormous size and one wonders how the host can accommodate so much bulk. It is conceivable that the body wall might break under the stress.

Predatory animals that might be involved include the following: American merganser, great blue heron, herring gull, kingfisher, bald eagle, otter and mink. The American merganser was more frequently observed than any of the other species. However, the herring gull was the only one observed in the act of using a boulder for a feeding station.—W. A. DENCE, *Roosevelt Wildlife Forest Experiment Station, State College of Forestry, Syracuse, New York.*

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[1] Contribution No. 7 from the Roosevelt Wildlife Forest Experiment Station.

MANACOPUS, A NEW NAME FOR A GENUS OF PHALLOSTETHIDAE.—Mr. Oehser, editor of the U. S. National Museum publications, has kindly called my attention to the fact that the use of the name *Acanthostethus* for a genus of fishes is untenable. It is the name of a genus of Hymenoptera, described by F. Smith in 1869, and was therefore preoccupied when I published it. Accordingly I propose the name ***Manacopus*** to replace it, the genotype and sole species being *Manacopus falcifer* (Manacop). For a diagnosis of the genus see my original article (The Genera of Phallostethidae; *Proc. Biol. Soc. Wash.,* 52: 139–144). The genus is named in honor of Mr. P. R. Manacop, in recognition of his studies of Philippine Phallostethidae.—ALBERT W. C. T. HERRE, *Natural History Museum, Stanford University, California.*

A NOTE ON *MONOGNATHUS.*—Dr. Léon Bertin has recently described what seem to be the most remarkable of the deep-sea Lyomeri (1936, Bull. Soc. Zool. France, 61: 538–539; 1938, Dana Reports, 15: 3–13). The three species are described and figured as lacking any vestige of the upper jaw elements. The absence of maxillaries, premaxillaries, palatines, pterygoids and other characteristic bones appears to indicate the most degenerate skull among teleostean fishes. Bertin has named a new family, Monognathidae, and the new genus *Monognathus* for the three new species, all originally described at the same time in the same paper, without designation of a type species.

While Dr. Bertin has handled the anatomical part of his work on these strange fishes well, the present writer is rather weary of the continued negligence of certain systematists in the bothersome but necessary subject of nomenclature. Is it too much to ask that those who do systematic zoology learn simple rules that should be known to every tyro of a taxonomist? The *International Rules of Zoological Nomenclature,* the amendments to them in the various *International Zoological Congresses,* and the *Opinions of the International Commission on Zoological Nomenclature* are certainly available to all.

No careful zoological systematist of the present day presumes to lay up nomenclatural trouble for future generations by neglecting to designate a genotype when proposing a new genus. The practice of designating generic type species has been general for over forty years, and is implicit in the *International Rules.* It was, indeed, made obligatory over ten years ago (X^{e} Congr. Internat. Zool., Budapest, 1927 (1929): 1588). The amendment to the *Rules* adopted at that time declared plainly that new generic names published subsequent to December 31, 1930, without definite indication of genotype, were not to be recognized under the *International Rules.*

Dr. Bertin's act in basing the new genus *Monognathus* on three new species, none of which is designated as genotype, is in clear violation of the amendment cited. Under strict application of the *Rules,* the name *Monognathus* has no standing in zoological nomenclature; the genus is still nameless and any one is at liberty to rename it. While such renaming would be fully justifiable, I think few zoologists would care to take such a radical step. However, some action should be taken, and I intend to take it. This action is especially necessary since two of the species of "*Monognathus*" differ so profoundly from the third that few ichthyologists would hesitate to recognize two genera, *and the absence of a genotype designation leaves it uncertain to which group Bertin's generic name should apply.* The genera of Monognathidae may, therefore, stand as follows:

1. *Monognathus.* Genotype *Monognathus taningi* Bertin. Vertebrae heavy, subcylindrical. Rostral tip of the ethmoid with two teeth. Dorsal fin originating over the third vertebra, its rays similar throughout. Urostyle (or last vertebra) prolonged to support a caudal filament. One species known, from off Gambia and the Cape Verde Islands.

2. ***Phasmatostoma,*** new genus. Genotype *Monognathus jesperseni* Bertin. Vertebrae slender, hour-glass shaped. Rostral tip of ethmoid toothless. Dorsal fin originating over the eleventh or twelfth vertebra, its median rays shortened and enveloped in adipose tissue. No prolonged urostyle or caudal filament, the pseudocaudal fin broad. Two species, *Phasmatostoma jesperseni* (Bertin) from off Sierra Leone (dorsal origin somewhat nearer snout than anal; D. 95; A. 55), and *Phasmatostoma bruuni* (Bertin) from the South China Sea (dorsal origin a little before anal; D. 75; A. 40).—GEORGE S. MYERS, *Natural History Museum, Stanford University, California.*

NOTE ON A HYBRID MINNOW, *APOCOPE* X *RICHARDSONIUS*.—Intergeneric hybrids have been thought for some time to occur among North American Cyprinidae. The evidence for such hybridization in this group is convincing, although largely circumstantial. A case of an apparent intergeneric hybrid has come to my attention. Two minnows, collected at Five Lakes, Placer County, California, in the same haul with *Apocope oscula* var. and *Richardsonius egregius*, cannot be placed with either of these forms or with any other known minnow from the region. They combine the characteristics of *Apocope* and *Richardsonius* in a striking manner, being in some respects like the former, in some like the latter, and in most others a blend of the two. The probability that they are hybrids seems very great. The environmental conditions necessary for hybridization appear to be present. Adult fish of the two parent forms were crowded together in the small outlet of the lake. Eggs were about equally developed in each, being not quite mature (July 13, 1939, elevation 7540 feet). No other species of Cyprinidae are known to occur in Five Lakes. The minnow fauna has probably been introduced from some part of the Lahontan system with plantings of trout, since *Richardsonius* is not recorded from the American River, which drains Five Lakes, and is, for the most part, alien to the Sacramento-San Joaquin drainage. On the other hand, it is one of the most characteristic forms in the Lahontan fauna.

COMPARISON OF THE HYBRIDS WITH *Apocope* AND *Richardsonius* FROM FIVE LAKES[1]

	Apocope	Hybrids (1)	Hybrids (2)	*Richardsonius*
Pharyngeal teeth	1,4–4,1(8)[2]	1,5–5,1	1,5–4,1	2,5–4,2(7) 2,5–5,2(1)
Standard length	47.6 to 61.0	62.3	60.5	59.8 to 92.0
Mean	52.5			82.9
Diameter of eye[3]	.036 to .045	.048	.046	.057 to .065
Mean	.040			.061
Length of head[3]	.209 to .244	.245	.233	.240 to .268
Mean	.234			.253
Shortest caudal ray into longest	1.33 to 1.76	2.07	1.56	2.02 to 2.31
Mean	1.51			2.13
Scales in lat. line	59 to 75	63	65	52 to 60
Mean	65			57.1
Dorsal rays	7 or 8	8	7	8 or 9
Anal rays	7	7	7	9 or 10

[1] Thirteen specimens each of *Apocope oscula* var. and *Richardsonius egregius* from Five Lakes were available for this comparison.
[2] Number of specimens.
[3] Measurements expressed in hundredths of the standard length.

The shape of the mouth differs in the two genera under consideration, and that of the hybrid appears as a blend of the two. Four specimens of the Five Lakes *Apocope* have no maxillary barbels, five have one on one side, and five have them on both sides. *Richardsonius* never has a maxillary barbel. One hybrid has a barbel on the left side.

The color patterns of *Richardsonius* and *Apocope* are considerably different (formalin-killed specimens in alcohol). In the specimens of *Richardsonius egregius* from Five Lakes the ventro-lateral surface of the body is pale, and it is sharply set off from the dark, dorso-lateral surface. The pale area always shows a few scattered flecks of dark pigment. A bright-red, lateral stripe is characteristic of this species. In the *Apocope* the dark, pigmented area extends much farther ventrally, and the pale area blends into it with no very sharp line of demarcation. The ventral area does not show flecks of pigment. Specimens of *Apocope* typically have two parallel lateral bands and numerous small, irregular blotches of darker pigment. One hybrid is darker than either parent, and in it the pigment extends farther ventrally than in any of the *Apocope*. In the other hybrid, which is not so dark, the pale ventral area extends farther dorsad than in any of the *Apocope*, and is more sharply demarked, particularly on the caudal peduncle. The flecks of pigment in the pale area in this specimen are like those in *Richardsonius*. However, the pigment extends farther down on the body than in *Richardsonius*. Interestingly enough, the specimen with the pigment pattern resembling most closely that of *Richardsonius* has the deeply cleft caudal fin, as in that form; and, conversely, the caudal fin of the other specimen is like that of a typical *Apocope*. Both hybrids show the lateral bands and dark blotches characteristic of *Apocope*. Neither has any indication of the red lateral

stripe of *Richardsonius*. The pigmentation of the peritoneum in the hybrid is uniform and dark, as in *Apocope*, and differs from that in *Richardsonius*, in which the peritoneum is lighter, and the pigment is isolated in large, distinct melanophores. Twelve of the thirteen specimens of *Richardsonius* from Five Lakes have the peritoneum pale; in one it is moderately dark. The melanophores are large and distinct in all. In nine of the *Apocope* the peritoneum is dark; in four it is pale. Individual melanophores are not visible to the naked eye either in the *Apocope* or the hybrid.

These specimens have been deposited in the Stanford University Natural History Museum, the catalogue numbers being 34338, 34339, and 34340 for the hybrids, the *Richardsonius*, and the *Apocope* respectively.—ALEX CALHOUN, *Natural History Museum, Stanford University, California.*

THE PROBABLE IDENTITY OF *SPHYRAENA CHRYSOTAENIA FROM* THE RED SEA AND ARABIA WITH *S. AUREOFLAMMA* FROM THE PHILIPPINES, WITH NOTES ON *NASO VOMER* AND *N. LOPEZI*.—Several years ago I first noticed the extraordinary similarity of the little red-striped barracuda of the Philippines with a species described by Klunzinger from the Red Sea. I have now carefully compared Philippine examples with Klunzinger's description and figure. Unless the Arabian fish possesses differentiating characters not evident from Klunzinger's account, I see nothing of importance to distinguish it from the Philippine fish. The synonymy would then be:

Sphyraena chrysotaenia Klunzinger

Sphyraena obtusata (*pro parte; nec* Cuvier and Valenciennes) Klunzinger, 1870, Verh. zool.-bot. Gesellsch. Wien, 20: 820 (Koseir, Red Sea).

Sphyraena chrysotaenia Klunzinger, 1884, Fische des Rothen Meeres, 1: 128–129, pl. 9, fig. 3 (Koseir, Red Sea); Boulenger, 1887, Proc. Zool. Soc. London, 1887: 664 (Muscat); Steindachner, 1902, Denkschr. Akad. Wiss. Wien, mathm.—naturw. Cl., 71: 145 (Gischen, Southern Arabia).

Sphyraena aureoflamma Seale, 1909, Philippine Journ. Sci., 4 (6), sect. A: 502 (Zamboanga); Fowler and Bean, 1923, Proc. U. S. Nat. Mus., 62: 17 (Cebu); Herre, 1927, Bur. of Sci., Manila, Pop. Bull. 3: pl. 17 (colored plate); Herre, 1934, Fishes of the Herre Philippine Exped. of 1931: 32 (Culion, Sitankai, Cebu).

Another Philippine fish, *Naso lopezi* Herre (1927, Philippine Journ. Sci., 34: 467, pl. 7, fig. 2) has been identified with a Red Sea species, *Naseus vomer* Klunzinger (1871, Verh. zool.-bot. Gesellsch. Wien, 21: 514; 1884, Fische des Rothen Meeres 1: 87, pl. 13, figs. 2, 2a) by Fowler and Bean (1929, U. S. Nat. Mus. Bull. 100, 8: 282). Discrepancies evident in comparison of the descriptions and figures led me to believe that *lopezi* might be distinct. I have now compared two Philippine examples of *lopezi* with Klunzinger's account, and important differences have become apparent.

In *vomer* the two pairs of caudal plates are very large and closely approximated dorsally, the distance between the two plates of the anterior pair being scarcely equal to one fourth the length of one of the scutes. In *lopezi* the plates are much smaller and the distance between the two plates of the anterior pair is equal to more than the total length of one plate. In *vomer* the length of the snout (judging from the plate) goes at least 2.33 times in the body depth, while in *lopezi* the snout length is approximately half the depth. Other differences of note observable in comparing Klunzinger's plate with specimens of *lopezi* can not now be definitely established due to the inadequacy of the descriptions of *vomer*. The body form, the shape of the opercles, and the relation of dorsal position to end of gill-cover, all seem to differ. Finally *lopezi* always shows spots on body, head and caudal, and a large light area close behind and above the pectoral base, while Klunzinger describes or figures no such markings on either fresh or preserved *vomer*. I think it is evident that *Naso lopezi* cannot be placed in the synonymy of *Naso vomer* without more definite evidence of intergradation in some important characters.—GEORGE S. MYERS, *Natural History Museum, Stanford University, California.*

REVIEWS AND COMMENTS

A LIVING COELACANTHID FISH FROM SOUTH AFRICA. By J. L. B. Smith, Transactions of the Royal Society of South Africa, Vol. 28, Part I, 1940: pp. 1-106, 19 figures, 44 plates.—The amazing discovery of the Recent Coelacanth, *Latimeria chalumnae* Smith, off the southeast coast of Africa in December, 1938, has aroused considerable public as well as scientific interest. The circumstances attending the discovery and the unfortunate loss of everything but the skin and part of the skeleton have been discussed, along with brief preliminary descriptions, in numerous articles appearing in *Nature* and several popular journals. This information is brought together in the introduction and in an interesting discussion of the habitat.

The present report is a very detailed account of the specimen as preserved. Although it was mounted and placed on exhibition in the East London Museum (South Africa), the author was fortunately allowed to make some dissections on one side. It must be stated that this account is remarkably thorough considering the amount of time that he was able to study the specimen.

The external features are thoroughly described, including scale counts and a discussion of scale histology. The author considers the scales to "represent an advanced stage of modification of the primitive cosmoid type, in which the cancellate bone-layer has disappeared, with consequent reduction in the thickness of the scale."

One of the interesting features of the Coelacanthini (Actinistia) is the absence of the maxillary bone. Since this group presumably evolved from the Rhipidistian stock, this bone must have been lost during the transitional period, of which there is no record. A certain lack of perspective is shown in the statement that the maxillary was never present because it failed to develop in any ancestral form. It would appear, however, that in the millions of years since the loss of this element, profound modifications could occur in the upper jaw which might suggest that it was never present.

The presence of an extracleithrum in the pectoral girdle is of considerable importance, being otherwise definitely known only in the Permian genus *Coelacanthus*. It might be mentioned here that *Latimeria* is considered by Smith to be related to *Rhabdoderma* and *Wimania*, probably more closely to the latter. This appears very reasonable.

The dermocranium is very similar to that in other Coelacanths. Apparently the bones of the cheek are not as well developed as in *Macropoma*, but more closely approximate a condition halfway between *Wimania* and *Axelia*. The assumption is made that three small bones just anterior to the squamosal are the remains of a quadrato-jugal. In this connection it may be noted that more extensive "fragmentation" has occurred in the cheek region of *Axelia*. In both cases it is unsafe to homologize these plates with specific bones, although the regions are undoubtedly homologous. There is an increase in the number of rostral and supraorbital (parafrontals of Smith) bones over other known Coelacanths. The frontal is divided into anterior and posterior divisions as in *Whiteia*.

The arrangement of the sensory canals of the head is almost identical with the condition in other Coelacanths, greatly facilitating the identification of the dermal bones. This canal system has been studied in great detail and should be very valuable in future work on fossil forms.

Another interesting feature is the double articulation of the lower jaw. The hyomandibular and symplectic, if correctly identified, are unique in that the latter does not unite the former with the quadrate. The symplectic articulates directly with the articular and the quadrate articulates in a socket composed of both the angular and the articular, a very extraordinary condition which the author thinks may be common to all Coelacanths.

The neurocranium is not completely preserved, the occipital region having been

removed by the taxidermist. Several very interesting features have been pointed out, however. It consists of a number of separate ossifications, as is the case for all Coelacanths from the Carboniferous on. The roof of the neurocranium is cartilaginous and not divided. There is evidence of only four gill bars instead of the five supposedly present in several of the Spitzbergen forms.

The notochord is persistent, covered by a cartilaginous sheath. Only the caudal portion of the column was preserved and in this region, that of the supplementary caudal, the lepidotrichia are attached directly to the chordal sheath, no radials being present.

The paper contains a number of excellent photographs and many instructive line drawings, including some reconstructed transverse sections of the skull.

It is earnestly hoped that more specimens of *Latimeria* will be caught in the near future so that the soft anatomy may be studied along with the missing parts of the skeleton.—Bobb Schaeffer, *Department of Zoology, Columbia University, New York.*

ADVANCES AND APPLICATIONS OF MATHEMATICAL BIOLOGY. By Nicolas Rashevsky. University of Chicago Press, 1940: 214 pp., 58 figs. $2.00.—Another book by Rashevsky serves to remind the biologist that mathematics is part of the training necessitated by modern science. In the present volume Rashevsky applies the principles developed in his previous work to certain problems of cellular physiology; notably diffusion, cell respiration, cell growth, cell form and movements.

Those not acquainted with the field covered by the *Bulletin of Mathematical Biophysics* may be misled by the title and turn to this volume expecting a treatment of statistics, a form of mathematics more familiar to the average reader of Copeia than the mathematical formulation of the physical laws involved in cell activity.—F. W. Weymouth, *Stanford University, California.*

THE GREAT NATURALISTS EXPLORE SOUTH AMERICA. By Paul Russell Cutright. The Macmillan Co., New York, 1940: xii + 340 pp., 41 figs. $3.50.—Those of us who are interested in such things have hoped that some day there would be written a saga of the naturalists who have explored South America, a great story of great men, shot through with glorious discovery and high adventure but even more with heartbreaking labor and painstaking observation that the world seems to have passed by and forgotten. The title of Dr. Cutright's book exactly fits such a saga, and the reviewer opened it with hope and a prayer.

The entire first chapter is given over to the explorations of the great naturalists, their biographies and a table of some of those who managed to exist to old age after braving the perils of the jungle, with a description of the greatest rain-forest in the world thrown in for good measure. We are exceedingly grateful that this account is illustrated by the portraits of two of the naturalists—Darwin and Humboldt. Having thus justified his title in 41 pages, the remaining 31 chapters—most of them entertainingly written and full of information—are devoted to sketches, mostly of single species, culled from the writings of the great naturalists (and others), with particular and macabre attention to case histories of those who were chewed by vampire bats, jaguars and chiggers, or became uncomfortable or defunct through the operations of caimans, piranhas, bushmasters and malaria.

The reviewer cannot deny the extraordinary experience of the author in the exploration of the popular works of the great naturalists.[1] Their books are (nearly) all in the six-page bibliography, though a few unimportant men like Agassiz failed to make the text. The author has wisely let the great men speak for themselves; no hint of his own observations is allowed to escape amid such august company. And such lesser lights as Spix, Martius, Natterer, Burmeister, Castelnau, Hauxwell, von Ihering, Simons, H. H. Smith, Goeldi, Haseman, Hatcher, Koch-Grünberg[1] and Eigenmann, who failed to write popular books (or to have them translated into English), are very rightly consigned to oblivion. Dyott, von Hagen, and A. Hyatt Verrill proved to be much more worthy, or at least of better advertising value.

Judging by the seven chapters devoted to reptiles and fishes, the author evidently felt it unwise to submit his manuscript to workaday naturalists for the checking up of details. Those who enjoy this volume will certainly not be those who are interested in such trifles.—George S. Myers, *Stanford University, California.*

[1] The author includes some anthropologists, or at least some who have made anthropological observations.

EINFÜHRUNG IN DIE VERGLEICHENDE BIOLOGISCHE ANATOMIE DER WIRBELTIERE. ZWEITER BAND. BIOLOGISCHE ANATOMIE DER ERNÄHRUNG. By Hans Böker. Gustav Fischer, Jena, 1937: XI + 258 pp., 260 text figs. RM. 13.50 [with the 25% discount, about $4.05].—Professor Böker's first volume, presenting his general ideas and plans for a "Biological Comparative Anatomy" and his treatment of the biological comparative anatomy of locomotion, was reviewed in the preceding number of COPEIA. This initial volume was so stimulating in its naturalist's approach to anatomical problems that his further volumes have been eagerly awaited. The second deals with the feeding habits of vertebrates, discussing successively the adaptations for the recognition of and search for food, for grasping it, for reducing it by mechanical and chemical means for swallowing, with briefer discussion of the physiology of resorption, excretion, and final section on the regulatory mechanisms which govern the organism as a whole (respiration, internal secretion, and nervous control). As in the previous volume, there is an extensive and suggestive bibliography. The third volume, which will conclude the work, is to deal with the biological anatomy of reproduction.

It is again obvious from a preliminary inspection that the work contains much novel material. The introduction amplifies Böker's philosophic premises, and it becomes clear that he wholly rejects mutation and natural selection as an explanation of the origin of biological adjustment to the environment or of the development of complicated organic mechanisms, in favor of some direct influence of the environment; the only clue to the author's ideas on the mechanism of such an influence is the reference (p. 46) to the "mnemic forces" by which the active reaction of the soma is transferred to the hereditary mechanism. American readers will trust that the quotations from "Mein Kampf" are a sop to necessity.

The interest of the factual text, once the philosophical introduction is hurdled, is great. The merits of the second part (as of Part I) lie in the renewal of contact between descriptive anatomical studies and observation of animals in life and especially in their natural environments. A more extended account of the content of this work is to be given elsewhere by my colleague, Mr. D. Dwight Davis. It is desired here to call attention to some of the more striking herpetological material.

The analysis of the modes of grasping food involves a whole series of new terms: suck-snapping, for example, to characterize the combination of a snap with the inrush of water in large-mouthed aquatic forms (catfish, giant salamander, matamata); for birds he distinguishes a whole series of types of aquatic feeding. The discussion of the function of the extraordinary buccal apparatus of the matamata is the first that has come to the reviewer's attention. Under the land-dwelling forms there is a description, with excellent figures, of the projectile tongue of plethodontid salamanders and of the chameleons.

The discussion of food getting by means of poison apparatus is weak. One wonders that the sting of the sting rays is mentioned at all in this connection. The discussion of the poison apparatus of snakes and its evolution, derived from Werner and Phisalix, is very inadequate; the fangs of elapid snakes, for example, are thought to represent a stage intermediate between that of the opisthoglyph and solenoglyph snakes. The suggestion that the venom of snakes aids powerfully in digestion deserves further investigation.

The second chapter deals with the mechanical reduction of food. There is an excellent figure and explanation of the egg-sawing apparatus of the egg-eating *Dasypeltis*, and the influence of hard food, especially crabs and mollusks, on tooth development of varanid lizards, as well as fishes, is reviewed.

In the physiological section, the chemical difference between the urinary excretions of mammals and reptiles is cited in support of the author's hypothesis of the independent origin of mammals and reptiles.

The final section of the book returns to the discussion of Böker's holistic principles. The reviewer wishes to emphasize again that the present work promises to stimulate interest in anatomical studies to an extraordinary degree.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

THE MEXICAN AND CENTRAL AMERICAN LIZARDS OF THE GENUS *SCELOPORUS*. By Hobart M. Smith. Zool. Ser. Field Mus. Nat. Hist., 26, 1939: 1–397, 59 text figs., 31 photogravure plates. $3.50.—The appearance of Hobart Smith's comprehensive treatment of the genus of North American lizards recommended by Cope for study "as an excellent *pièce de résistance* for those persons who do not believe in the doctrine of derivation of species" is a most welcome herpetological event. While some herpetologists will be disappointed in the exclusion of the forms in the United States from detailed treatment, this does not seem to the reviewer to be a valid criticism. It is clear that a monographic treatment of the genus would be premature; Dr. Smith writes from Mexico of the discovery of additional undescribed forms; and our knowledge of the factors which limit the distribution of even the better known forms is scanty. While it is more than ever clear that the Mexican region is one of extreme faunal complexity, all zoologists working in this field will welcome both Dr. Smith's attempt at an arrangement into faunal areas and his maps of the ranges of species.

A more detailed appraisal of the work must depend on continued use of its keys and diagnoses. The descriptions are often so elaborate and so inadequately comparative and selective, as to be difficult to follow. Some modification of the longer lists of localities might also be possible. Dr. Dunn, in letters to the reviewer, suggests citing only those which serve to define the limits of ranges. Even these details will doubtless prove useful in further examination of specific problems.

It should perhaps be mentioned that the name *Sceloporus lundelli lundelli*, attributed to the reviewer in a previous paper (Smith, 1938, Occ. Pap. Mus. Zool., Univ. Mich., 388: 16), is there a *nomen nudum;* its original description appears on page 66 of the present work. It was Dr. Smith's intention to have *lundelli* appear over the reviewer's name in a long-promised but still delayed paper on the reptiles of British Honduras.

Field Museum press is to be congratulated on the appearance of the volume, which is complete with extensive bibliography, table of contents, and index. J. A. Allen's paper on the distribution of North American mammals referred to on p. 16, is omitted in the bibliography. Certain of the figures, taken from other papers, might have been modified to advantage by placing the lateral views of heads horizontally. The map of Mexico used for plotting distributions appears to have been prepared especially for this work; it is neatly modified to suit specific purposes. The photogravure plates are occasionally disappointing, but are in general effective presentations of habitus and color pattern.

The work is a monument to the energy and enthusiasm with which Dr. Smith and Dr. Edward H. Taylor have renewed the herpetological exploration of Mexico.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

DESERTS. By Gayle Pickwell. McGraw-Hill Book Co., New York, 1939: I-XIV, 1–174, pls. 1–64. $3.50.—Dr. Pickwell's excellent photography brings the pictorial beauty of deserts to his book, in which both text and plates serve as an elementary introduction to the geography and natural history of this most extraordinary of land habitats. The work is to be recommended not only to children, but to persons of all ages who may be making the acquaintance of the deserts of our Southwest, even if it be only from a train window.

The six pages and fourteen plates devoted to the herpetology of the Mohave and Colorado deserts may serve as an introduction, but they are far from presenting an adequate account of the relations between reptiles and the desert habitat. The reviewer misses especially photographs showing something of these relations, such as one of the tracks of the side-winder. No mention is made of other sand burrowing snakes, and the account of the horned toads misses the essentials of their xerocole habits. There cannot be too much emphasis on the smallness of our present knowledge, and on the opportunities for increasing it available to the layman. The section on desert problems could well have been revised and amplified with this in mind. To mention only one example, observations on the actual speed of desert animals, such as lizards and snakes, are few and inadequate, and while it may be admitted that a stop-watch and a tape measure would add to their accuracy, such observations require at bottom no more equipment than ingenuity, a watch, and a pair of legs.—KARL P. SCHMIDT, *Field Museum of Natural History, Chicago, Illinois.*

EDITORIAL NOTES AND NEWS

Annual Meeting

THE twenty-third Annual Meeting of the American Society of Ichthyologists and Herpetologists will be held in Toronto on Monday, Tuesday and Wednesday, September 2-4, 1940. Sessions will be held at the Royal Ontario Museum of Zoology, corner of Bloor Street and Avenue Road. The Board of Governors will meet on Sunday evening, September 1 at 8 P.M. in Private Dining Room No. 6, Royal York Hotel, Front Street opposite Union Station. The International Association of Game, Fish and Conservation Commissioners and the American Fisheries Society will meet at the Royal York Hotel, Toronto, September 2-6. The Annual Dinner of the Ichthyologists and Herpetologists will be held in the Great Hall, Hart House, University of Toronto, on Tuesday evening, September 3. Entertainment is being planned for ladies who may not wish to attend the technical sessions. Titles of papers should be sent to the secretary of the local committee before August 15th. The members of the local committee are J. R. DYMOND, Chairman; W. J. K. HARKNESS, Treasurer; E. B. S. LOGIER, Royal Ontario Museum of Zoology, Secretary; W. J. LERAY, and ISOBEL LIMBERT.

Aid to Copeia

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News Item

SPORTSMEN OF THE STATE OF NEW HAMPSHIRE in recognition of the outstanding work in fisheries research done by the late EARL E. HOOVER, former Biologist for the New Hampshire Fish and Game Department, have established in his honor a scholarship at the University of New Hampshire for a student in Wildlife Management, that will enable the one chosen to attend the summer Forestry and Wildlife Camp at Passaconway, New Hampshire.

Obituary

JOHN F. BASS, JR., of Englewood, Florida, died on December 19, 1939, at Mexico City after a brief illness. Mr. Bass was well known for his active interest in biological research, an interest which prompted him to open the Bass Biological Laboratory, in 1934, as an aid to independent investigators. At the time he was stricken with his fatal illness he was attempting to facilitate cooperative work between the biologists of the United States and Mexico.

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